Transforming Joint Air and Space Power

The Journal of the JAPCC

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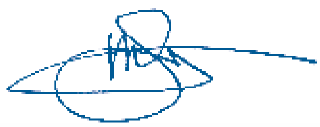
After four thrilling years in Kalkar, my tour as the JAPCC Assistant Director and my time as the Editor of this Journal ends in August 2018. Editing the Journal was probably one of the most time consuming, but rewarding, tasks I had in my entire portfolio. The countless contributions we received from authors throughout the Alliance, and even beyond, were thought-provoking, innovating, educational, but most of all down-right great reads. I thank all of you, readers and authors alike, that have helped make this journal such a valuable asset in JAPCC's transformational toolbox.

This said, I am particularly excited about the Journal issue in front of you. It kicks off with a highly enlightening interview with Major General Tonje Skinnarland, Chief of the Royal Norwegian Air Force. Sharing with us her views on Norway's demanding path towards modernizing NATO in the North, she elaborates on the challenges of integrating fifth-generation capabilities to include new C2, competence and mindset requirements at the joint level. Her insight acts as a natural springboard for the two follow-on articles. In the first, Major General (ret.) Tim Zadalis explains how advanced Multi-Domain C2 (MDC2) could enable commanders to leverage enhanced decision-making capability to direct forces across domains and missions. The second provides a JAPCC perspective that very thoroughly, and critically, examines whether NATO, at this point of time, is sufficiently joint to begin earnest discussions regarding MDC2.

In this Edition we then move on to other significant transformation and capability topics, such as the future of close air support, suppression of enemy air defence, rotorcraft fleets, and automated air-to-air refuelling. Additionally, a duo of Anglo-French authors present their viewpoints about fourth- and fifth-generation integration challenges for F-35 partners, as well as implications for Alliance nations not participating in this transformation process. A very appropriate companion piece from the European Air Group explains how its Combined Air Interoperability Program could help solve such generational integration issues. Switching gears to missile defence, our Journal elaborates on options to enhance the European contribution to the Alliance's sea-based missile defence capabilities, followed by an essay about the role of ballistic missile defence in NATO deterrence. We close with an article illuminating hybrid warfare and NATO's current approach to countering hybrid threats.

Thank you for taking the time to read this edition of our Journal. I congratulate the authors on their contributions and I strongly encourage our readers to consider sharing your thoughts as you go forth and advocate for Air Power. The JAPCC team greatly appreciates your feedback and thoughts. Please visit our website at www.japcc.org, like us on LinkedIn or Facebook, or follow us on Twitter to give us your opinion. With your continued interest and support, the JAPCC Journal will remain in the vanguard of Airpower dialogue!



Madelein Spit
Air Commodore, NLD AF
Assistant Director, JAPCC

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We encourage comments on the articles in order to promote discussion concerning Air and Space Power.

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Joint Air Power Competence Centre
Gen Tod D. Wolters

Executive Director
Joint Air Power Competence Centre
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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.

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Modernizing NATO in the North

The JAPCC's Interview with Major General Tonje Skinnarland, Chief of the Royal Norwegian Air Force

What is your view, as a NATO Air Chief in the North, on our current security situation?

First, I would stress that in the European part of the Alliance we need to pay attention both to the South, East and the North. In many ways, the different regions have different challenges. However, isolated incidents in one region could inflict consequences in other regions. The challenges are interlinked; a potential threat to the Baltic regions will immediately affect the north and vice versa.

Norway considers ourselves to be the NATO gatekeeper of the north, monitoring the northern flank. Since the Cold War, Norway has kept a close eye on military strategic developments in the Barents Sea, on behalf of the Alliance. This is a huge responsibility, and we are putting a lot of effort into making sure we maintain a good situational awareness for the Alliance.

This situational awareness is of great importance, as we are the closest neighbour to the world's largest non-western concentration of military power. The Kola Peninsula and the Arctic are of great importance to Russia's power projection capability. The current modernization of the Northern Fleet will increase their capability, as we see a renewal of a wide range of weapon systems. This renewal will continue to have an impact on our ability to operate in all domains, should we see increased tension in the security climate.

The main task of the military forces on the Kola Peninsula is strategic nuclear deterrence. Russia continues to operate a nuclear triad consisting of strategic nuclear missiles, bomber aircraft and submarines. One of the primary areas of operations for strategic submarines is the Barents Ocean north-east of Norway, which is why Russia's military has established the Bastion Defence, a multi-layered Anti-Access/Area-Denial (A2/AD) system with the capability to project force into the North Atlantic Ocean and to disrupt allied sea lines of communications. And I have to underline; this A2/AD capability is already established in the North and we see the same challenge in the Baltics, the Black Sea and the Mediterranean Sea. It's forcing us to adapt our plans to the reality.

What is Norway's answer to the changed security environment in our Northern Region?

Norway pursues the goals of predictability and stability in the north. We believe that we do this best from a position of strength. That is why we are investing in strategic capabilities that will enhance our ability to take care of security in our region. In the 2016 long-term plan for our armed forces we are investing in high-end capabilities relevant to our security requirements. Intelligence, surveillance, Maritime Patrol Aircraft, fifth-generation combat aircraft and submarines are key lines of effort in our development.

As an Air Chief I would like to mention the F-35 and the P-8 in particular:

- The F-35 with its long-range, precision-guided Joint Strike Missile (JSM) ensures that we will be able to strike even well-defended targets, both on land or at sea, at extended distances. This strengthens our ability to deter any potential opponent.

- The P-8 will ensure Norway's ability to remain NATO's gatekeeper in the north. Strategic surveillance and intelligence in the maritime domain are vital to NATO's situational awareness, and therefore a high priority mission for Norway.

Norway and several of our allies are integrating fifth-generation capabilities, which give us more strategic impact. This also means that we will need to shorten our readiness time. We used to have weeks and months to prepare. Now we need to be ready in hours.

The Royal Norwegian Air Force is currently adapting in accordance with Norway's Long Term Plan. How will this affect the Royal Norwegian Air Force?

In addition to the previously mentioned purchases, the Long Term Plan confirms the need for protected and sustainable bases. With the current technology development around us, we need to make sure that our bases are sufficiently protected. We are therefore concentrating our activity towards fewer, but more protected air bases. This starts with early warning. In the next years, Norway will purchase new long-range radars, in order to give us increased early warning.

Thereafter, we need to make sure that we can handle incoming threats. Therefore, the government has highlighted the importance of a multi-layered Ground Based Air Defence. We are also working on our Force Protection concept for our bases. All of these projects are being handled in close cooperation with the Norwegian Defence Research Establishment, which makes me confident that the decisions made today, will give us what we need for the future.

What do you see as the biggest challenge with all the fifth-generation capabilities being introduced in NATO?

From my point of view, the most important factor is our ability to make sure that our air command and control, and therefore our contribution to Joint command and control, is up to the new standards. I would specify it to two areas: System and competence.

The introduction of NATO Air Command and Control System (ACCS) will be one of the cornerstones in our NATO Integrated Air and Missile Defence System (NATINAMDS). My concern is on three main topics: Cost, time and performance. If the end product ends up being further delayed, too costly for the nations, or with a performance that will reduce the effect of our new capabilities, then we are moving in the wrong direction. We can't have a fourth generation command and control system managing fifth-generation capabilities.

Secondly, we need to change our view on competence. Air Power has always been strategic by nature. And as our assets increase their strategic impact; our airmen also increase their strategic impact. This goes all the way from our airmen at the squadrons, to the airmen at the strategic level.

We will, therefore, need to change our mindset and look closely into how we train and educate our airmen. Fifth-generation capabilities need fifth-generation competence. This must be developed, and we also have to make sure that we have the right competence in the right position. This is especially true on the joint level, as there will be an even greater demand for air assets in the future.

With the introduction of fifth-generation assets, might this cause a change in Norway's security policy?

Fifth-generation air assets will give more options to the politicians, but I don't see it changing our main principles. I would say that the main lines of Norway's security policy will remain consistent for the years to come. Our security policy is based on collective defence and credible deterrence.

Credible deterrence for Norway means standing firm with our allies, exercising our sovereign rights, and making our strategic interests clear – to remain a stable and predictable neighbour from a position of strength. Deterrence is of fundamental importance in every war-preventing strategy.

Our defence concept is based on the premise of involving allied reinforcements early on in a crisis, and as seamlessly as possible.

Allied training is therefore of vital importance to us. The Arctic Challenge Exercise is a great example of this. An exercise built on the successful cross-border training that the Nordic countries have developed into one of Europe's largest air exercises.

A formation flight of Norwegian Air Force F-16s during Exercise Arctic Challenge 2017.

In 2018 we will also host the Trident Juncture exercise in Norway. This will be a great opportunity for us to make sure that we are on the right path in the development of our ability to receive allied reinforcements. This will also be a great opportunity for our airmen to work in a joint and international environment. After all, we train, we fight, and we win *together*.

Where do you see the Royal Norwegian Air Force in 10 years' time?

In ten years' time, we will be finished with the process of phasing in most of our new capabilities, like the F-35, the P-8 and new GBAD and early warning radars. We plan to be fully operational capable (FOC) at fewer, but more protected bases than today. We will continuously work on the development of our cooperation with other forces, both nationally and internationally.

To summarize Norway's path towards this end state, I would say that it will be demanding with such a large restructuring of our Air Force, but I'm confident that our airmen will overcome the challenges that lay in front of us. However, we must also be careful to not look far ahead only. In the shorter term, we are working hard to increase our readiness and sustainability. At any time, we must be ready to fight with what we have if deterrence fails.

Major General Skinnarland, thank you for your time and your comments. ●

Major General Skinnarland

started her military career in the Royal Norwegian Air Force's control and reporting branch in 1988. With this background, she has worked at all levels including Commander of the 130th Air Wing at Air Force Station Maageroe from 2007–2010, and as detachment commander of the Air Control Unit during Operation Baltic Accession from 2004–2005. Her experience in the Norwegian Ministry of Defence includes a period as acting Second-in-command of the Department of Security Policy and operations. Since 2015, Major General Skinnarland has served in various positions in the Air Force Staff, including a period as project leader for the re-organization of the Royal Norwegian Air Force's top-level command structure. Having previously filled the position as Chief of Air Staff, Skinnarland was appointed as the acting Norwegian Air Chief in 2016, before she was promoted to Major General and became the actual Air Chief at the beginning of 2017.

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Multi-Domain Command and Control

Maintaining Our Asymmetric Advantage

By Major General (retired) Tim Zadalis, US Air Force

'War is the realm of uncertainty; three quarters of the factors on which action in war is based are wrapped in a fog of greater or lesser uncertainty. […] The commander in war must work in a medium which his eyes cannot see; which his best deductive powers cannot always fathom; and with which, because of constant changes he can rarely become familiar.'
Carl von Clausewitz, On War

Introduction

As the pace of technology accelerated the availability of cutting-edge military knowledge, ill-gotten or developed, allowed potential adversaries the opportunity to close technological gaps that have long kept a qualitative combat edge for the United States, NATO, and coalition partners. In many domains, once seemingly insurmountable advantages are closing.

The evidence is compelling: our adversaries have invested heavily in fifth generation airpower, stealth, and hypersonics; their prowess in cyber threatens not only the military, but also the civil infrastructure and institutions which militaries protect; and space is no longer the remote frontier of a few nations but is now a silent battlefield for many. Keeping ahead of an adversary's development and fielding of near-parity systems is an expensive endeavour. Investments must be made in promising future technologies if we are to maintain our advantage. Equally, if not more important, is investment in areas where capabilities of each domain is leveraged to create warfighting synergies and link all domains – one such area is Command and Control (C2).

For decades, US and NATO Air Forces have fielded C2 systems enabling us to maintain dominance in the air. Arguably challenged at times by seams, but rarely by warfighting capabilities and like-minded air warriors. However, C2 as we know it will not support warfighting needs in future multi-domain conflicts, whether with near-peer adversaries or faceless non-state terror organizations. Our adversaries have analysed our systems, capabilities, and tactics attempting to minimize our advantage in every domain, and continued reliance on timely cross-domain information sharing between separate air, land, maritime, space, and cyber Operations Centres will not serve the needs of future warfighters. What is needed has become known as Multi-Domain Command and Control (MDC2) – the ability to seamlessly analyse, fuse, and share what was once domain-centric information into a single C2 system that supports all domains and all levels of war.

The Emergence of MDC2 in the US Armed Forces

For the US Air Force, C2 is the foundation of peacetime deterrence, humanitarian response, and combat capability. The current family of C2 systems is the envy of adversaries and it is an 'asymmetric advantage' in multiple domains. In the coming decades, if implemented correctly by the US Air Force and NATO, MDC2 will preserve the asymmetric C2 advantage and may usher in the next Revolution in Military Affairs.[1] That fact, was recognized by the US Air Force Chief of Staff, General David L. Goldfien as he selected MDC2 one of his top three priorities during his tenure as Chief of Staff.[2] At his direction the US Air Force has embarked on a journey to create an integrated C2 system between domains in which information is quickly analysed, integrated, and disseminated. The project is headed by Brigadier General Chance Saltzman and he is about to release the first strategy document titled *'Multi-Domain Command and Control Campaign Plan Strategy Document'*. The document sets forth the initial strategy for achieving MDC2 in the air, space, and cyber domains. Initially three Lines of Effort are identified including reassessing and refining Operational Concepts, leveraging Advance Technology, and improving Support Structures. While the document is US Air Force centric, it is clear the strategy recognizes the importance of a broader MDC2 system in the Joint and NATO arena.[3]

The US Air Force is not the only US service researching future C2. In October 2017 the US Army released a draft document, *Multi-Domain Battle: The Evolution of Combined Arms for the 21 Century*, detailing how future US and coalition forces might seamlessly operate in multiple domains.[4] Implicit in the concept is C2. In order to leverage thinking in both services, the Air Force and Army have agreed to partner in a series of experiments designed to explore the components of Multi-Domain Battle C2.[5] These joint experiments dovetail with previously announced Air Force MDC2 wargames scheduled beginning this fall. Both efforts will set a foundation for the development of MDC2 Joint Doctrine. Equally important, the initial work can and will set the stage for a broader MDC2 system that support warfighters in all domains – air, space, cyber, land, and maritime.

MDC2 Experiments and Wargames

At this stage of development, the MDC2 concept is tailor-made for experiments and wargames. These efforts are designed to test outside-the-box concepts and challenge the criticism that we prepare for the last war. Good concepts become capability, and poor ideas inform thinking for the next round of experimentation and wargaming. These are vital tools and significant emphasis must be placed on them lest they become an academic exercise with lessons learned destined for dusty military archives.

Strong emphasis on MDC2 was evident during the Global Engagement 2016 wargame where multi-service planners incorporated MDC2 thinking into a fictitious, but realistic, Article V-based scenario set in Europe. The fast-paced scenario was fought with limited assets in a short period of time. Since it was a wargame, future capabilities and force structure were added, and a 'stepping-stone' MDC2 construct was used with the goal of closing the gap between deliberate planning and dynamic re-tasking. The underlying assumption was a cyber-secure, cloud-based, and adaptive MDC2 system that integrated and shared information between all domains – from sensors to trigger pullers and between all component operations centres. The Joint Task Force commanders quickly moved assets between subordinate forces regardless of parent component. Mission-type orders were issued and the assets needed to accomplish the mission, regardless of parent service and nation, were allocated to the field commander for defined period of times to accomplish a specified mission before shifting to the next priority.[6] The goal was to explore future C2 concepts, and most importantly, to learn.

There were numerous lessons learned from the planning sessions and wargame execution. MDC2 can greatly improve operational awareness at all levels, shorten the F2T2EA 'Kill Chain'[7] and increase combat effectiveness if done correctly. However, it highlighted the biggest vulnerability: a cyber compromised MDC2 cloud-based structure.

MDC2 Vision

At this point, a fictitious example may help to illustrate MDC2. Imagine, decades from now NATO is locked in a contest with an adversary. A space-based sensor supporting the Alliance picks up an Electronic Intelligence hit on a mobile Anti-Access/Area Denial Surface-to-Air Missile system. It cues other ISR assets that quickly corroborate the identification. Within a cyber-hardened cloud-based structure Processing, Exploitation and Dissemination (PED) occurs using state-of-the-art Artificial Intelligence (AI). Immediately tens of thousands of digital OODA loops occur at a speed John Boyd could only imagine.[8] Information is shared, updated, and fused in a high-speed iterative process. Within seconds tactical recommendations with risk information begin to appear at the MDC2 Operations Centre. To destroy the target the commander has options: In the air, an armed Remotely Piloted Aircraft is overhead, F-35s are nearby and can be re-tasked, or a B-21, with the load out to destroy

MDC2's analogy with playing chess: The art of chess strategy is knowing how to formulate a plan (conduct joint operational planning) for the chess game (the mission), and arrange your chess pieces (use assets of multiple domains in a joint fashion) to accomplish this plan.

the target, will be in range in 35 minutes. On the ground, an Army High Mobility Artillery Rocket System unit can easily strike the target, or there is a Special Forces unit operating covertly nearby. At sea, a Navy cruiser and a submarine stand ready with next generation Tomahawk Land Attack Missiles. And last but not least, reliable partisan forces, who want their territory back, stand ready to act. The multi-domain savvy Commander uses operational art to determine the optimum solution for neutralizing the target. Field Commanders are issued Mission-type orders and assets. Then using decentralized authorities, the field commander manoeuvres as necessary to destroy the target.

MDC2 Requirements

As MDC2 concepts mature in the coming years an overarching combined-arms Grand Strategy is needed so that each Service and NATO MDC2 strategies can nest under. Without one, the risk of integration challenges in the future increases tremendously, especially between nations. Failure in implementation threatens capability and drives up future C2 costs at the expense of other warfighting capabilities. Clearly, now is the time to accelerate collaboration and develop a MDC2 Grand Strategy.

Soldiers: © US Air Force, Staff Sgt. Alexander Riedel
Chessboard: © cobisimo/shutterstock

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Lockheed Martin has set up a small air operations centre at its Center for Innovation in Suffolk (Virginia), where the company is running MDC2 experiments in partnership with the US Air Force and joint partners. The first three experiments in 2016 and 2017 were primarily focused on building air tasking orders. The fourth experiment (planned for August 2018) will move beyond the planning process into the actual conduct of combat operations.

Another sign that we are moving in the right direction is the addition of US Army and Navy O-6s (NATO OF-5s), along with officers from Five-Eyes nations to Brigadier General Saltzman's MDC2 team.[9] This collaboration crosses service and national boundaries will result in a unified vision and Grand Strategy. Clearly, expansion of NATO participation is needed.

Cyber security and Information Technology (IT) highlight why a Grand Strategy is needed. Cyber and IT support for MDC2 at the service, component, and national-level depends on developing an impenetrable and resilient system. Advances in computing speed and capacity, machine-to-machine and machine-data-human interfaces, Artificial Intelligence (AI), Deep Learning and the ethics surrounding semi-autonomous weapons all require significant investigation, and all will contribute to an effective MDC2 system. Equally critical are undeveloped cyber capabilities of the future and partnering with industry will tease needed capabilities out in the years to come. However, all MDC2 efforts will be for naught if we cannot secure the systems.

Operationalization of MDC2 requires a fundamental shift in how we protect IT systems. Since the beginning of the digital age militaries have fielded systems that focused on delivering warfighting functions. Cyber protection, while not an afterthought, has focused on protecting systems from penetration with firewalls, 'patching' security gaps, employing robust encryption algorithms, and constant monitoring by cyber warriors. Future adversaries, whether state-sponsored or lone-wolf actors, will continue attempts to exploit vulnerabilities. Therefore, it is imperative the next generation of IT assets supporting MDC2 focus on cyber security and encryption from the onset, and add compliant functionalities to an already secure construct. This is a paradigm reversal. If done correctly, the hardened cloud-based structure will set the stage for the MDC2 RMA. Do it wrong and we commit ourselves to building on a system that has proven vulnerable in the past. Stated another way, develop the cyber security protocols upfront, keep them on the cutting edge, and require capabilities-based systems to comply with the standard.

As we look to develop a cloud-based construct to support MDC2 we may have to look no further than ACC's Combat Cloud initiative. The ongoing project seeks to fuse 'big data' from multiple systems that normally do not communicate with each other into a single, coherent picture for analysts and warfighters.'[10] It is the digital equivalent of today's PED process supported by AI. And if done right, ACC's Combat Cloud has a much broader future beyond the near-term goal of supporting air, space, and cyber Air Force operations. ACC's Combat Cloud can become a stepping-stone for Joint and NATO MDC2 integration. Expanding the vision for ACC's Combat Cloud, again, requires a long-range Grand Strategy to achieve a seamless MDC2 capability.

Summary

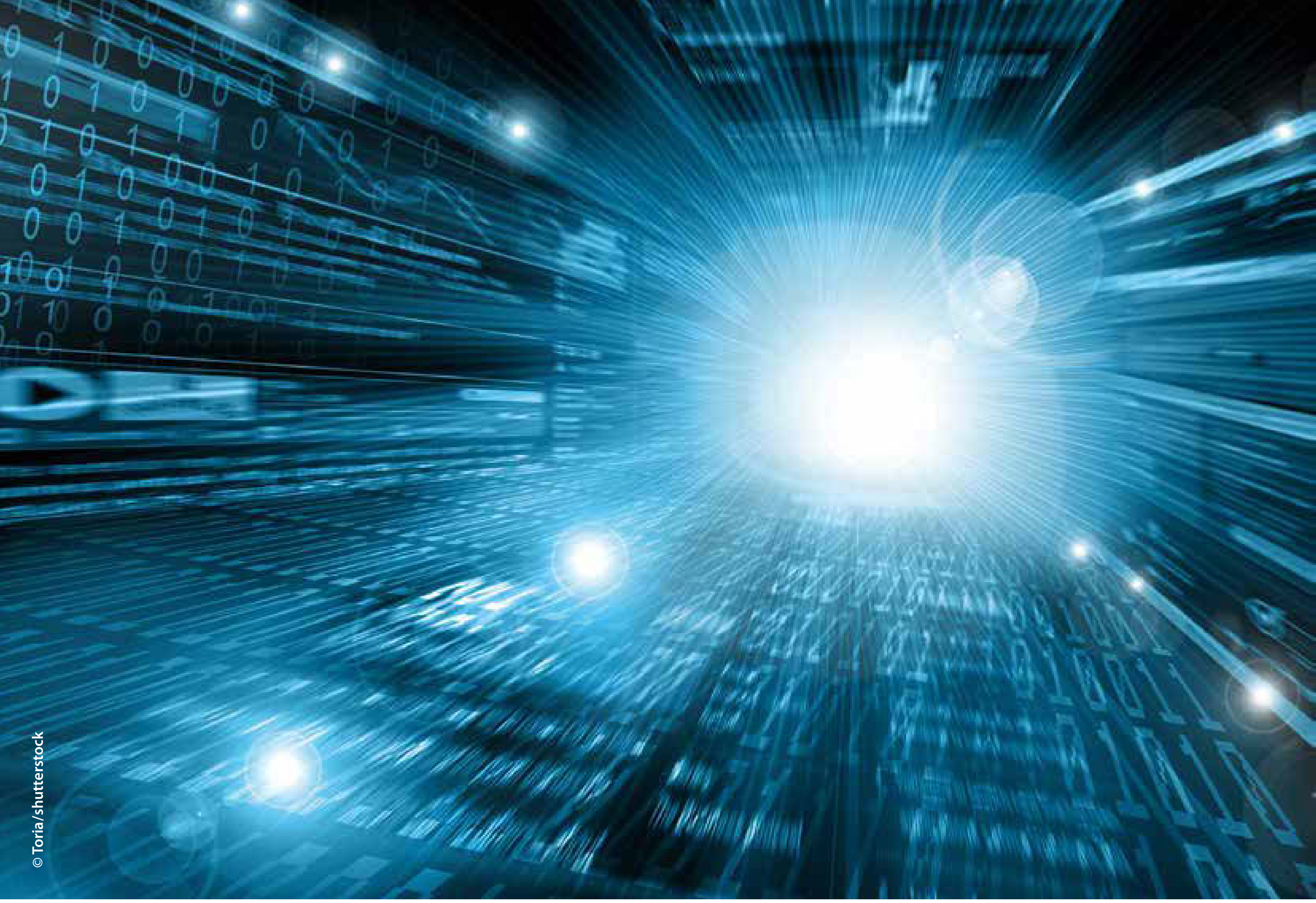
So, what is needed for MDC2? Continued robust intellectual debate on how to maintain our C2 asymmetric advantage, and about MDC2's future role. To help focus service and national efforts, an overarching vision and Grand Strategy is needed. Vigorous service and national development must continue with an eye towards overall integration. Aggressive engagement with industry to leverage cutting edge work, especially in cyber protection and AI is needed. A robust schedule of experiments and wargames must separate MDC2 capabilities from wasteful rabbit holes. Begin educating and training MDC2 professionals with the goal of making multi-domain thinking the standard among all warriors. Prioritize IT and cyber security development and place it at the forefront – MDC2 will be easily exploited if we don't. And finally, as we vigorously pursue MDC2 we must be mindful, a half-hearted effort will commit us to foolishly spending billions on a potential concept that will never be achieved. However, an 'All In' attitude will usher in the MDC2 Revolution in Military Affairs and maintain C2 dominance for decades to come.

We will never be able to completely remove the 'fog' and 'uncertainty' Carl von Clausewitz wrote about; however, with a well-thought out and implemented MDC2 system, our commanders will operate with a clearer picture and transfer the fog and uncertainly to our adversaries. ●

1. Daniel Goure's article is available at: https://www.realcleardefense.com/articles/2017/12/06/the_next_revolution_in_military_affairs_multi-domain_command_and_control_112741.html
2. Goldfien, Gen David L., Chief of Staff Focus Area, Enhancing Multi-Domain Command and Control, Tying it All Together, USAF, Mar. 2017.
3. Expect the formal release this spring.
4. US Army release occurred in Oct. 2017. Available at: http://www.arcic.army.mil/App_Documents/Multi-Domain-Battle-Evolution-of-Combined-Arms.pdf
5. McCullough, Amy, Air Force Magazine, 24 Jan. 2018. Available at: http://airforcemag.com/Features/Pages/2018/January%202018/The-Future-Fight-Must-Be-Truly-Joint.aspx.
6. Under the concept of Mission Command, field commanders are tasked to 'conduct military operations through decentralized execution based upon issued mission-type orders'. These nest under the commander's intent and provide field commanders with the latitude necessary to accomplish the mission. See US Joint Chiefs of Staff, Mission Command White Paper, 3 April 2012. Online at: http://www.jcs.mil/Portals/36/Documents/Publications/missioncommandwhitepaper2012.pdf
7. Find, Fix, Track, Target, Engage, Assess.
8. 'OODA Loop' refers to the Observe-Orient-Decide-Act Loop is a model developed by US Air Force Col John Boyd to describe to military operational decision-making. It applies to all levels of war and has non-military applications in the commercial sector.
9. Clark, Collin, 'Rolling The Marble': BG Saltzman On Air Force's Multi-Domain C2 System, Breaking Defense, 8 Aug. 2017. Available at: https://breakingdefense.com/2017/08/rolling-the-marble-bg-saltzman-on-air-forces-multi-domain-c2-system/
10. Whittle, Richard, ACC Intel Head Seeks 'Combat Cloud', Breaking Defence, 28 Oct. 2015. Available at: https://breakingdefense.com/2015/10/acc-intel-head-seeks-help-creating-the-combat-cloud/

Major General Timothy M. Zadalis

retired from the US Air Force in 2017 after nearly 34 years of distinguished service. His diverse career includes a wide variety of joint assignments including tours at US Transportation Command, Central Command in support of Operations Enduring and Iraqi Freedom, Southern Command in support of Haiti earthquake relief, he is a Northern Command 'Plank Holder', an Airborne Emergency Action Officer for Strategic Command, and served as ISAF Joint Command Director of Air Plans/Programs in Kabul, Afghanistan during the 2010–2011 operational surge. His Air Force career culminated as Vice Commander of US Air Forces Europe and Air Forces Africa. General Zadalis has expertise in air mobility, nuclear, world-wide airpower command and control, contingency operations, humanitarian relief, leadership development, and training and education. He is a Command Pilot with over 4,400 flight hours and qualified in 10 training and operational aircraft. General Zadalis' active duty biography is available on the US Air Force website.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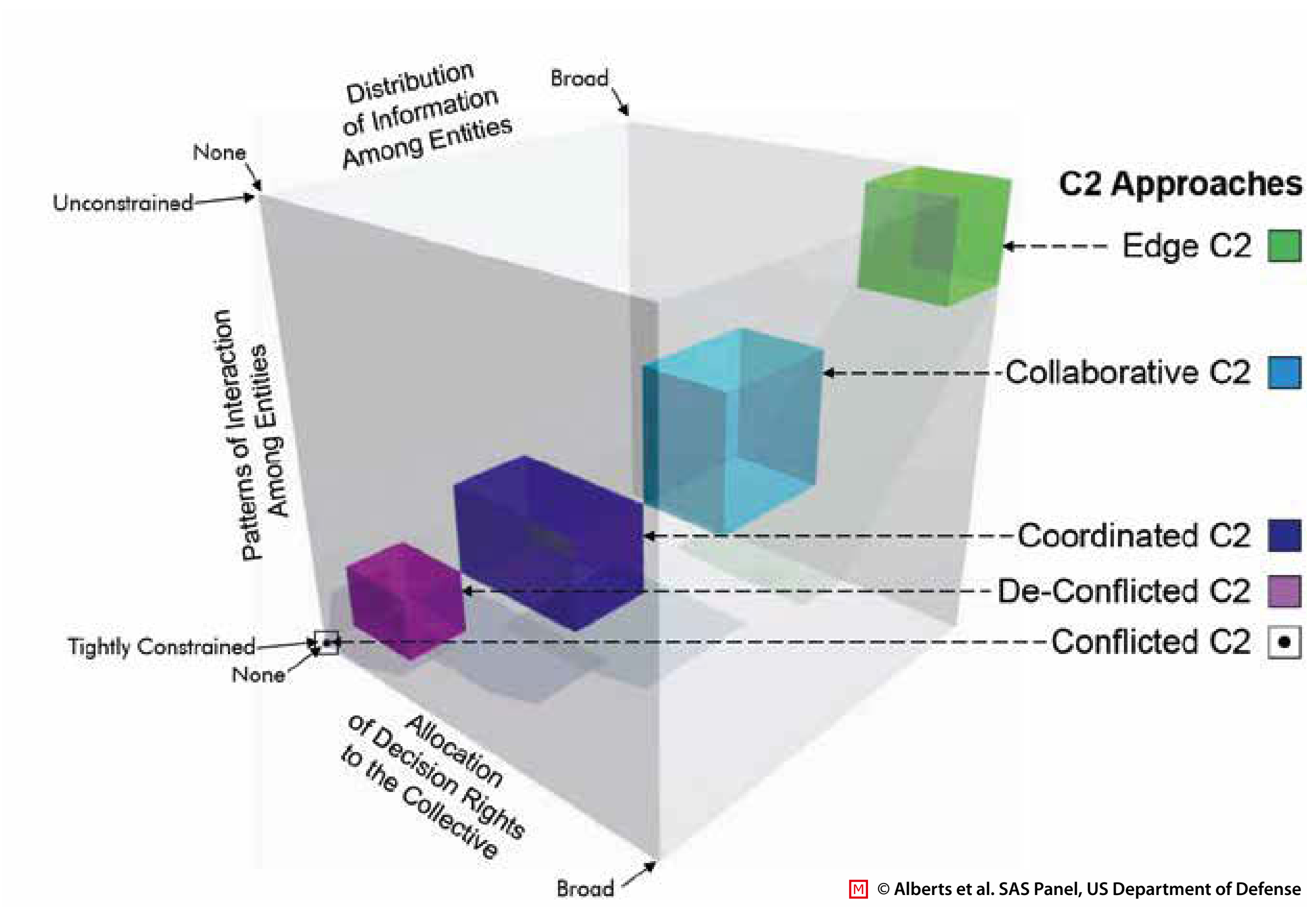
On Multi-Domain Operations

Is NATO Today Sufficiently 'Joint' to Begin Discussions Regarding Multi-Domain Command and Control?

By Captain William Perkins, US Navy, 7th Fleet
By Lieutenant Colonel Andrea Olivieri, ITA Air Force, JAPCC

Introduction

Recently, there have been multiple think papers, studies and articles proposing a new way of viewing the future battlespace. Many of these treat the entire environment as one single domain or an integrated environment of multiple domains which overlap and are mutually supporting. Sceptics believe Multi-Domain is nothing more than a new paint job applied to the 1980s Air-Land Battle concept, which placed emphasis on the full three-dimensional nature of modern battle and described Maritime, Air, Land and Space based systems working together to defeat an adversary. However, the US Air Force Chief of Staff (CSAF) recently explained it this way: 'Multi-domain is much more than the ability to work in multiple domains […]. It is also more than operations in one domain supporting or complementing operations in another domain.'[1]



NATO System Analysis and Studies (SAS-065) C2 Maturity model demonstrating the levels of achievable C2 and the three axis of influence to produce a change in *maturity* level.

Following the CSAF's comments, the Tri-lateral Strategic Steering Group (TSSG) comprising the US, UK, and France, investigated the concept of Multi-Domain Warfare.[2] Believing that future adversaries will blend conventional, asymmetric and hybrid capabilities across each of the traditional physical domains (Air, Land And Maritime) plus Cyber and Space, they postulate that a more comprehensive approach to dealing with this security threat is needed to operate in this type of 'multi-domain environment'. Furthermore, they assert that not only is this multi-domain operations concept a potential for the future but that elements of it already exist within the US, British and French national perspectives on warfare today.

This characterization of the future battlespace begs intriguing questions: Is the Alliance operating today at a level which supports exploration of multi-domain operations? Perhaps more apropos, is NATO today as Joint as it can be, or should be, to support planning milestones toward multi-domain (beyond today's vision of joint)? Are individual Nations? Before any of us can even begin a serious discussion of MDC2, a look in the mirror regarding today's realistic level of Joint capability is warranted.

C2 Maturity Levels: From Joint to Multi-Domain

Allied Joint Doctrine for the Conduct of Operations, AJP 3 (B), refers to a Joint operation as one which endeavours to synchronize the employment and integration of the capabilities provided by Land, Maritime, Air, Space, Cyberspace, Special Operations and other functional forces. Therefore an understanding of the capabilities and limitations of each Component in a Joint Force is crucial to achieving 'Jointness'.[3] A fundamental principle of Joint warfare is the recognition and acceptance of separate domains in which operations are principally led by one Service/Component. These domains are 'Joint' when capabilities within one component overlap with and are exploited to influence another domain. Therefore, not only can advances in one Component's particular domain be made by leveraging some of another Component's capabilities, but in fact, assistance may be required from outside one Component to achieve success within that Component's specific domain. So, are we currently deeply synchronized at a Joint level and ready to transition to Multi-domain? To answer that question we have to understand where we want to go.

To arrive at the assessment of the future battlespace environment, the JAPCC's 'Air Warfare Communication in a Networked Environment (AWCNE)' study reviewed the conclusions in the Joint US DoD Command and Control Research Program and the NATO System Analysis and Studies (SAS-065) which outlined levels of C2 maturity. Based on Alberts et alia's *'Maturity Model'*[4] and a review of NATO's recent operations and exercises, the authors concluded that while Collaborative and/or Edge C2 is the goal within NATO, the **'level of C2 maturity in the Alliance today can best be described as only functioning between the De-conflicted and Coordinated levels'.** In other words the Alliance conducts operations where Service/Component missions are segregated or at best partially coordinated for mutual effect rather than being fully synchronized (which would meet the criteria of 'collaborative C2' as outlined in the NEC model). This is significant in that a truly Multi-domain C2 capability would require at least Collaborative, if not Edge C2.

The C2 maturity assessment is based, most significantly, on differences in the technology of platforms and software which do not interface seamlessly. As an example of some of these challenges within NATO, the Bi-SC


The Maritime Component is able to project power on, above and below the sea. Many nations view the maritime battlespace as multi-domain already.

Air-Maritime Coordination Working Group (AMCWG) has been investigating for years the challenges to the exchange of the Recognized Air Picture between ships at sea and Combined Air Operation Centres (CAOCs) ashore, which is currently inhibited by both technical interface issues and Alliance policy issues (accreditation).[5] Another example which is restricting NATO's C2 maturity is that not all NATO Nations' aircraft are Link-16 capable, restricting where, when and how these aircraft may be employed in the Joint fight. Consequently, the Alliance has some significant technical, procedural and policy challenges to overcome before realistic advancement in its C2 maturity can occur.

Lessons Identified from Recent NATO Joint Operations and Exercises

The 2014 NATO Summit Communique (Wales) stated that NATO nations 'will ensure that their Armed Forces can operate together effectively, including through the implementation of agreed NATO standards and doctrines'. However, there is recognition within the Alliance that we are not meeting our own defined expectations.[6] Although 'operating together' is more about ensuring interoperability of forces during multinational operations, it is implicit within the verbiage that NATO must ensure it operates jointly as well as multinationally.

Why is this happening? One of the reasons is that we have endemically shunned the Joint perspective. For example, in 2010 the NATO liaison program, which provided standing liaison capability between the Single Service Command (SSC) Headquarters (HQs), was dis-established with a vision of 'virtual integration'. The functions each liaison element performed in daily staff meetings or in supporting planning efforts would, theoretically, then be conducted via distance support from each respective home HQ. During 'actual' operations, these liaison cells are formally established per NATO doctrine, but the standing, day-to-day liaison functions have largely atrophied as the personnel to perform them are no longer available. For example, Allied Air Command (AIRCOM) and Allied Maritime Command (MARCOM) are both executing STANDING day to day operations without these liaison elements. This has resulted in SSCs compartmentalizing day to day operations planning and has exacerbated poor integration of planning efforts leading into major exercises, as well as perpetuating a lack of knowledge about the capabilities and limitations resident within each of the sister-components. **Significant lessons identified show that the Alliance is challenged even when executing the basic tenets of Joint warfare, never mind being postured to take a leap into a battlespace requiring a higher level of interoperability.**

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NATO's exercise program excels at multinational execution and is focused on improving the joint elements of these types of endeavors.

The JAPCC, along with NATO's Maritime Air (MARAIR) Commander, co-chairs the annual Bi-SC Maritime Air Coordination Conference (MACC), a forum specifically created to address coordination issues between air and maritime components. In 2017, MARCOM and AIRCOM drafted and submitted to SACEUR a white paper outlining the five most pressing integration issues, binned into Personnel, Procedures and Technical Issues categories, which have been 'in work' for over a decade with little headway made.

A second product of the 2017 MACC was the development by the JAPCC of a briefing entitled 'Component Integration Challenges stemming from Advanced Layered Defense Systems (A2/AD)', expanded beyond just air and maritime to the entire Joint force. The JAPCC, together with experts from the NATO CAOC in Uedem, Germany, and Naval Striking and Support Forces NATO (STRKFORNATO), developed this comprehensive overview based on more than five years of observations on Joint integration in NATO exercises since 2010, with a specific eye toward identifying improvements necessary to succeed in operations against a near-peer adversary. This roadshow briefing has been presented to Joint Force Commands (JFCs) Brunssum and Naples, MARCOM, AIRCOM, STRKFORNATO, NATO Special Operations Headquarters (NSHQ), the Joint Warfare Centre (JWC) and the Senior Mentors for exercise Trident Javelin 2017.[7]

Efforts have been made in the last five years to provide rigour to the 'Trident' exercise series, however, a few observations may encapsulate the level of Joint warfare which the Alliance is capable of operating at today, and shed light on the challenge in moving forward toward a multi-domain concept.

Overall, training audiences in NATO's exercise program often struggle with Joint Operations, both in planning and execution. During the Road to War preparation for exercise Trident Javelin 2017, each of the Components and the JFC HQ conducted Battle Staff Training and operational planning separately, not only in different locations but at different times. This resulted in three separate mini-campaigns (Air, Maritime and Land) rather than a synchronized set of single-Component activities choreographed to achieve effect. This notable lack of Joint coordination at the operational level (JFC) is not an isolated occurrence and results in a lack of coherent operational design. This manifests in a few ways:

First, many staffs are not interested in the Joint fight in exercises, rather there is a tendency for the operational level to be enamoured with the Land battle and expect Maritime and Air operations to serve only as enablers to achieve the Land fight. For this reason, NATO rarely exercises Day Zero, but rather hits the fast-forward button to accelerate further into the campaign so that the Land fight becomes the predominant

Air Operations Centres provide links to combat capability within other components through the respective liaison elements. Developing a properly trained joint force requires both academic sessions and first-hand experience working in a joint environment.

focus of activities during the execution phase. The final result of this is to skip the hard Joint integration issues necessary to 'fight to get to the fight'.

Secondly, NATO training audiences sometimes fail to follow NATO doctrine in exercises, most notably in Air Defence (AD). Based on observations in many different exercises, it is the authors' opinion that none of the Components fully understand our AD doctrine. This is reflected in a lack of awareness between the Maritime and Air components staffs about terms such as Combined Air Sea Procedures (CASP)[8] which define the Tactical Control (TACON) relationship between the Air and Maritime component of the AD capable ships, and is further manifested by friction between the Land and Air component about the location, use and control over advanced AD systems (such as Patriot) which are frequently miss-classified as Army Organic AD, contrary to NATO doctrine.

Third, there remains a persistent belief that NATO will have full clarity of the battlespace in all future operations. This belief is founded upon the reliance on Intelligence, Surveillance, Reconnaissance (ISR), specifically imagery, and a lack of understanding of the electromagnetic environment, which will in many cases be degraded or denied by an adversary. In the most challenging exercise scenarios, NATO's intelligence collection capability is significantly impacted by adversary countermeasures, which necessitates a more thorough analysis at the Joint level not only to integrate and fuse collection methods to generate a picture but requires a more detailed and rigorous analysis of the Joint targeting process itself to maximize effect. However, many training audiences baulk at any scenario in which degradation to intelligence collection is imposed. This speaks to an underlying lack of awareness, or lack of appreciation, of adversary capabilities. The lesson NATO needs to take forward from this is to improve not only our analysis of adversaries and the environment but to more thoroughly integrate Joint collection capabilities to counter the effects of service degradation better and to improve the Joint targeting process.

Finally, the exercise structure itself struggles when juxtaposed against the requirement to generate qualified forces/staffs to achieve NATO's stated Level of Ambition.[9] The set of certification exercises require that forces achieve certification and frequently have only a limited opportunity to address or correct significant shortfall areas. Often, results are 'doctored' not only to ensure certification but also to assuage the cultural conditioning of many staffs to 'only look good, never be challenged or fail' in exercises. Rather than embracing a fail-assess-adapt-improve process for exercises, many staffs and training audiences expect certification just for showing up, espousing a pervasive belief in the infallibility of NATO weapons systems and a disregard for peer adversary capabilities.

How Can NATO Improve its Jointness?

One of the challenges experienced by Member Nations of the Alliance spans both national and NATO chains of command. Officers and senior-NCOs are frequently not exposed to Joint operations, nor have they completed requisite Joint training, until well into their careers. It is not uncommon for an officer to be serving their first tour of duty in a Joint assignment at the OF-4 (Lieutenant Colonel or equivalent) paygrade. It is this level of experience which is the major muscle behind the development of operational plans, and those same officers, through no fault of their own, bring service and national 'bias' to their planning due to a lack of knowledge or experience with other elements of the Joint force.

To address this lack of 'Jointness' the TSSG proposed the creation of a specific career path devoted to developing operational level staff to not only fight jointly but to understand how to employ the spectrum of Joint capabilities across a multi-domain environment.[10] Similarly, 'The (US) Air Force will work to build a C2 workforce cadre of officers to engrain the expertise and proficiency at a career level rather than see personnel cycle in and out on short-term rotations'.[11]

While an interesting concept, this idea is contrary to what some authorities espouse. That is, a future operational level staff (Joint) must be comprised of experts in each of the single service capabilities, and that is not something that comes from the classroom, rather it takes years of tactical/tactical-operational level experience to develop. So, what can be done to create more highly capable Joint officers while keeping a balance with their parent Service's core competencies?

To improve its 'Jointness', and to improve the effective use of air power in a Joint environment as the first step toward multi-domain operations, NATO must be able to address two questions:

1. How is NATO currently training air component commanders to plan air campaigns and to plan the Air Power contribution to a Joint campaign?
2. What needs to be done to tailor any existing training/exercises to better prepare commanders to plan for, and exercise, Air Power in Joint campaigns?

Currently, the training curriculum at the NATO School in Oberammergau offers two courses to address Joint operations. The Comprehensive Operations Planning Course aims to educate military officers (from Major to Colonel or equivalent) to contribute to NATO's operations planning process either as a Joint operational-level or functional-area planner while applying the principles of the Comprehensive Operations Planning Directive (COPD).[12] Second, the Strategic Operational Planning Course teaches how to apply the COPD within the framework of the Comprehensive Approach and is directed at NATO and partner officers (military from Major to Colonel, or civilian equivalent) working primarily in the Strategic NATO Headquarters or more generally in an assignment related to strategic level planning.[13] Furthermore, for airmen, the Deployable Air Command and Control Centre (DACCC) in Poggio Renatico (Italy) offers a course for Joint Air Operations planning that focuses on the tactical employment of air assets within a Joint campaign, i.e. with some but limited attention on operational-level effects-based and comprehensive planning. All of these courses, however, are relatively new to the NATO lexicon and although they appear to hit the mark, the annual throughput is rather low for a variety of reasons.

Conclusion

Any movement towards multi-domain must begin with changes in how we develop our personnel. As this 'MDC2 career concept' takes further form, for it to succeed it must ensure our personnel are truly Joint-trained and Joint-minded, while retaining the expertise in Component capabilities that allow them the be 'expert' in the first place. This requires exposure to the full spectrum of Joint capabilities in both educational and operational settings, earlier in the career, and perhaps the opportunity to serve longer to spend more time in the Joint environment prior to assuming planning and eventually leadership roles in a Joint Force or future MDC2 environment.

Also, today's operations and exercises demonstrate that NATO is mired at the De-conflicted level of C2 maturity, and has a long way to go before it is truly capable of Joint operations at the Collaborative level.

This is significant in that the Collaborative level of C2 maturity in Alberts et alia's model is required before any meaningful discussion can occur regarding Multi-Domain operations. To get there, C2 system interfaces must evolve beyond their current capability and road-blocks to sharing must be removed. As expressed by General Goldfein, *'if the Air Force wants to build a single global network linking Forces in the Air, Sea, Land, Space, and Cyberspace, it must first eliminate the proprietary standards that keep its existing systems from sharing data.'*[14] In reality, this may be beyond the scope of today's systems.

Many of the challenges identified in this article are widely known but not publicly acknowledged outside of meetings between frustrated staff officers. Ultimately, until we are willing to have some uncomfortable conversations about our current level of 'Jointness', Multi-domain will remain a worthy, but unreachable goal. ●

1. Douglas Skinner 'Airland Battle Doctrine'. 28 Dec. 1988. Available at: http://www.dtic.mil/dtic/tr/fulltext/u2/a202888.pdf
2. The Trilateral Strategic Initiative is a US, UK and French venture aiming at increasing trust, improving interoperability and advocating for air power. A Trilateral Strategic Steering Group (TSSG), comprising senior officers from the three Nations and sitting in strategic location close to each of the Air Chiefs, was created to oversee the Initiative.
3. Allied Joint Doctrine for the Conduct of Operations. Mar. 2011. Chapter 1, Paragraph 0128, p. 1–8.
4. Alberts et al. NATO NEC Maturity Model. Produced by the Centre for Advanced Concept and Technology, 2010. Available at: http://www.dodccrp.org/files/N2C2M2_web_optimized.pdf [accessed 17. Sep. 2015].
5. As identified in the Air-Maritime Coordination Conference 2017 minutes. Available at the NATO Standardization Office Protected Website in the Air Maritime Coordination Team section.
6. 2014 NATO Summit Communique.
Available at: https://www.nato.int/cps/en/natohq/official_texts_112964.htm
7. The 'Component Integration Challenges stemming from Advanced Layered Defense Systems (A2/AD)' brief may be accessed at JAPCC's classified website under the A2AD tab.
8. See AJP 3.3.1 and ATP 3.3.3.1 for more details on CASP.
9. As derived from the 2010 Strategic Concept for the Defense and Security of the Members of NATO, 20 Nov. 2010.
10. 'Multi-Domain Command and Control' presentation by Group Captain Crawford, RAF, at JAPCC Air and Space Power Conference 12 Oct. 2017.
11. 'Air Force Studying the Future of Coordinated Air, Space, Cyber ops' Mark Pomerlau, 17 Nov. 2017. C4ISRNet. Available online at: https://www.c4isrnet.com/c2-comms/2017/11/17/air-force-wrapping-up-study-on-how-to-use-air-space-and-cyber-in-the-2030s/
12. Course Description at: http://www.natoschool.nato.int/Academics/Resident-Courses/Course-Catalogue/Course-description?ID=55
13. Course Description at: http://www.natoschool.nato.int/Academics/Resident-Courses/Course-Catalogue/Course-description?ID=115
14. Sydney J. Freeberg. 'Top Air Force Effort, MDC2, Threatened by Proprietary Data: Goldfein.' In Breaking Defense. 26 Jul. 2017. Available at: https://breakingdefense.com/2017/07/top-air-force-effort-mdc-2-threatened-by-proprietary-data-goldfein/

Captain William A. Perkins

is designated as P-3 Orion Weapons & Tactics Instructor in the US Navy and on his seven deployments he has flown combat missions in every operational theatre in which the P-3C operates. In 2012, he completed a successful aviation squadron command tour as Commanding Officer of Tactical Air Control Squadron 11. A prolific author and strategist, his work has been published in Jane's Defence Weekly, Jane's Navy International, US Naval Institute's Proceedings, Joint Warfare Centre's Three Swords and in the Journal of the JAPCC. In addition, while assigned to the JAPCC, he wrote three strategic level studies on NATO maritime and air integration challenges. He is currently serving as the Director of Fleet Operations (N3) for the Pacific based US Seventh Fleet.

Lieutenant Colonel Andrea Olivieri

joined the Italian Air Force in 1989 and is a qualified Navigator and Tornado Weapon System Operator.
He participated in the US Air Force Student Undergraduate Navigator Training program in Randolph AFB (Texas) and subsequently graduated at the Tri-national Tornado Training Establishment in Cottesmore (UK). As an aircrew with 154 Sqn he participated in the flying Operations in Bosnia and Kosovo and the Ground Operations in Iraq. Between 2007 and 2014, he served as Chief Current Operations in the Italian Air Operations Centre in Poggio Renatico and contributed, as an ATO Coordinator, to the Operation Unified Protector in Libya. He is currently stationed in JAPCC – Kalkar, as a Precision Guided Munition Expert.

Future Battlefield Rotorcraft Capability

Operating in the Land and Littoral Environment Anno 2035

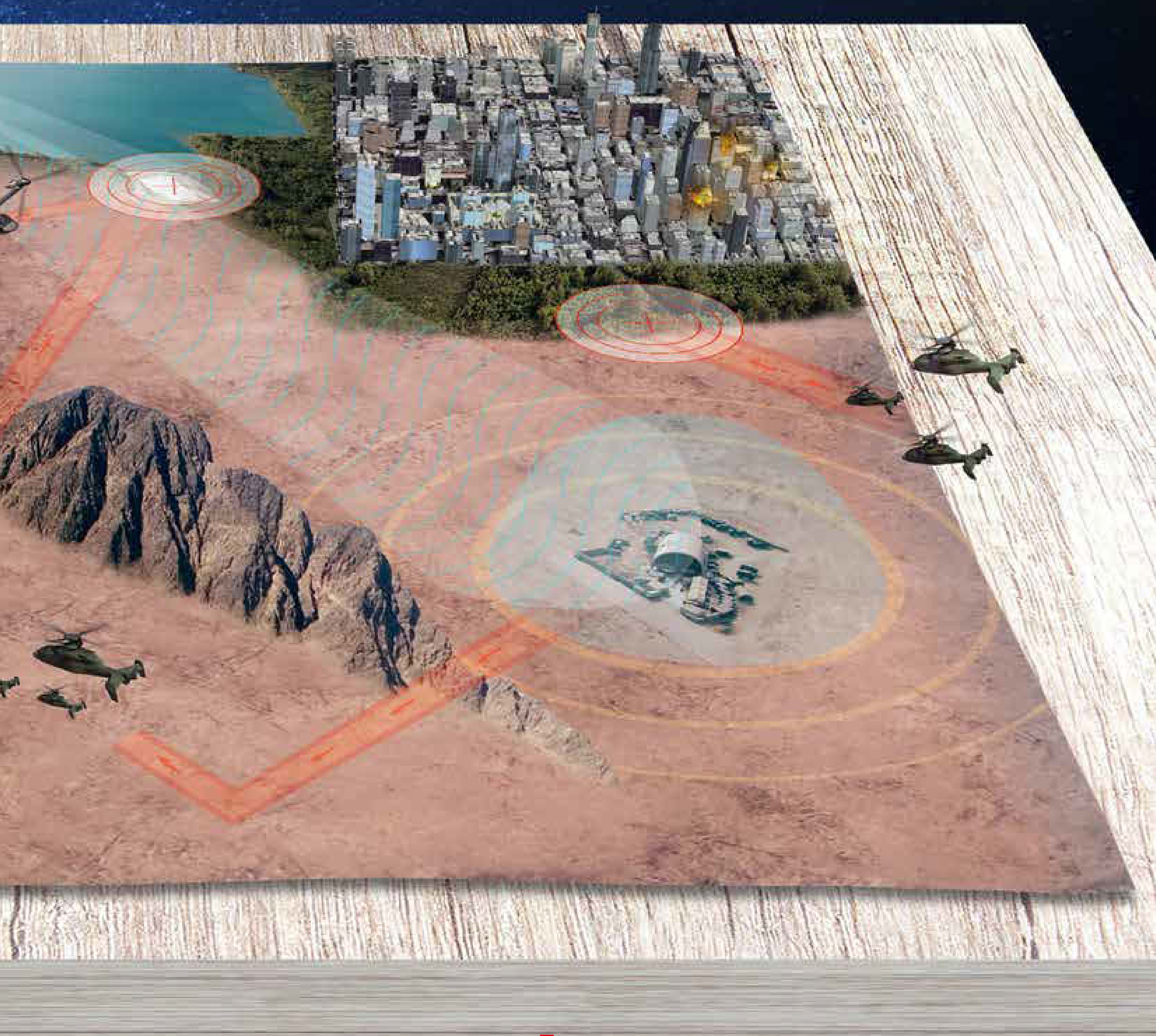
Part 3: Defining the Capability

By Colonel Wim Schoepen, BEL AF, JAPCC

Having established some technological requirements in the first article[1] and the most obvious user requirements in the second[2], this third and final article will be dedicated to drawing the sketch of a possible Future Battlefield Rotorcraft Capability[3] (FBRC). For the sake of brevity, this description will remain limited to the Material (M), Organization (O), and Interoperability (I) lines of development in accord with the DOTMLPFI[4] methodology defined by NATO Allied Command Transformation (ACT). Relevant developments in current programs related to Future Vertical Lift (FVL) will also be integrated to illustrate progress and provide food for thought with regard to essential choices that eventually will have to be made.

The Hardware

Based on the conclusions drawn in the previous two articles, the ideal future capability would consist of both manned and unmanned rotorcraft of different sizes for maximum operational effectiveness and



efficiency, and as such be hybrid in nature. For the purpose of distinction those sizes will further be designated 'light', 'medium', and 'heavy'.

Establishing such a fleet, with different types of rotorcraft and the ground support equipment required to operate, will certainly have a large financial impact on nations interested in the development of the FBRC.

It is likely many nations within the Alliance will not be able or even willing to acquire and operate this complete array of rotorcraft. Nations might decide only to change their current inventory with the similar FBRC variant or acquire another variant to complement an updated legacy capability. However, this will come with a considerable impact on interoperability and thus capability since major differences in performance are to be expected.

Eventually, Force Commanders will require balanced, deployed fleets to execute the wide array of missions in the most effective and efficient way. Being NATO's catalyst for the transformation of capabilities, ACT has a big role to play in this process over the next five to 15 years.

Manned Transport Rotorcraft

Manned Transport Rotorcraft will remain the backbone of the Hybrid FBRC. The light manned transport rotorcraft should be able to lift at least six fully equipped soldiers or 1,200 kg of cargo at full operational range. The medium manned transport rotorcraft should be able to lift at least 15 fully equipped soldiers or 3,000 kg of internal cargo at full operational range or 4,500 kg of total cargo, a part of which externally, at reduced operational range. The heavy manned transport rotorcraft finally, should be able to lift at least 45 fully equipped soldiers or 9,000 kg of cargo at full operational range, or 12,000 kg of total cargo, a part of which externally, at reduced operational range.

Specialized transport rotorcraft for MEDEVAC, Personnel Recovery, and Special Forces operations will more than likely be based on the medium or even heavy variant where the excess of internal space and cargo load capacity can cater for additional equipment, weapon systems, and fuel without deteriorating performance.

Unmanned Transport Rotorcraft

As an indispensable complement to the manned rotorcraft, the unmanned transport rotorcraft should come in two different sizes, 'light' and 'medium', for optimal effectiveness and efficiency. The larger one would be primarily used to execute routine resupply missions between Forward Operating Bases (FOBs) and Logistic Support Bases (LSBs). It should be designed

The Aerial Reconfigurable Embedded System (ARES).

with a modular cargo bay allowing easy loading and unloading of standardized containers, which would reduce not only the footprint of personnel and equipment involved but also decrease the required handling time. Similarly, the smaller one, which primarily would be used to execute punctual or emergency resupply missions, should boast identical design features, but on a much smaller scale to allow them to enter and leave difficult-to-reach locations within the engagement areas.

Both designs should equally allow loads to be carried externally, in the form of underslung loads, whenever the situation does not permit actual landings. Even though these unmanned rotorcraft will need to be able to operate fully autonomously, provisions should be made to allow terminal control by task force operators whenever the situation calls for it.

In 2013, the US Defense Advanced Research Projects Agency (DARPA) selected the Aerial Reconfigurable Embedded System (ARES)[5] to fulfil this essential role. This project is currently in its third and final phase and aims at developing an unmanned transport rotorcraft that could transport a payload of approximately 1,360 kg at speeds in excess of 250 knots. In its current stage of development, it would virtually cover all of the required characteristics of the previously mentioned light, unmanned transport rotorcraft.

Combat Rotorcraft

The combat variant would arguably be based on the medium or even light version of the manned transport rotorcraft. It could use the same total load capacity for a comprehensive array of defensive and offensive weapon systems. Additional fuel reservoirs could extend range or endurance, allowing it to fully execute its role as a provider of superior, Situational Awareness (SA) and Fire Support (FSp). Additionally, it will need to be able to command and control manned and unmanned combat aircraft to counter an ever-wider range of threats.

Within the framework of the (US) FVL program, the S-97 'Raider' is the prototype of the first 'next-generation' light tactical combat rotorcraft. It is currently in the phase of flight trials and technology demonstration, preparing the introduction of the SB>1 'Defiant'[6] as one of the two remaining contenders in the more than 100 billion USD US Army program to replace its current (medium-sized) helicopter fleet. The SB>1 is a

S-97 Raider

SB>1 Defiant

V-280 Valor

Joint Multi-Role Technology Demonstrator (JMR-TD) based on a co-axial rotor and clutched push-propeller propulsion system. The other JMR-TD contender, the V-280 'Valor',[7] is expanding on the tiltrotor technology introduced by the V-22 'Osprey'. Both companies will eventually be requested to procure a transport and a combat variant in the new 'medium' size category of next-generation rotorcraft.

On Speed and Range

Although the requirements are still being refined within the FVL program, the notional concept for a 'medium' rotorcraft specified the capability to carry up to 12 troops in 'hot-and-high' conditions at altitudes of 6,000 ft (1,800 m) and temperatures of 95°F (35°C). It should have a combat radius of 230 Nm (425 km), an overall unrefuelled range of 460 Nm (850 km) at a cruise speed of 230 knots (425 km/h). Two observations need to be made while considering these requirements. First, we need to understand that they were based on recent operational experiences and consequently do not necessarily reflect future application. As pointed out in my previous article, there are arguments to support the statement that more important user requirements are not specified at all.[8] Second, it is important to consider certain design choices will invariably favour some requirements at the expense of others.

Chapter Organization – The FBRC will Need to be Lean and Mean

The 'Organization' part of the FBRC will invariably be the result of trade-offs between operational and tactical demands, security and force protection constraints, and logistic support considerations. Traditionally, deployed helicopter units have large logistic footprints. They need sheltered infrastructure, a significant number of technicians, and a huge amount of readily available spare parts to reduce operational downtime of the different platforms. In addition, helicopters require considerable amounts of fuel to operate.

The most obvious way to circumnavigate these problems lies in the design of the different rotorcraft of the FBRC. One of the main requirements of the clients, and consequently objectives for the manufacturers, is to develop next-generation rotorcraft that would need significantly less maintenance than is the case today. Because of the mix of types and sizes expected in the FBRC, research and development of zero-maintenance components, the extensive use of easy-access Line Replaceable Units (LRU), and maximum commonality in sub-systems are of utmost importance. All of the above is far from impossible as proven by the US Marine Corps, which has been successfully operating the AH-1Z 'Viper' and UH-1Y 'Venom' for quite a number of years. Based on rather old and different helicopter designs, these two front line helicopters now share 84 % of parts commonality, thus significantly reducing their logistic footprint while dramatically increasing combat effectiveness.[9]

To decrease the logistic footprint of deployed FBRC units further, technology and tight organization could bring easy and affordable solutions. A significant reduction of spare parts stockpiles could be achieved by the extensive use of advanced 3-D printing and, as stated before, a very high degree in the commonality of parts and sub-systems. Although the requirement for relatively large stockpiles of fuel would persist, easy solutions could be found to reduce this to acceptable levels by having the (unmanned) transport rotorcraft that are executing the routine resupply missions refuel at the LSBs and not at the FOBs, thus reducing the required fuel stocks at the FOBs.

Another organizational consideration could be to put a significant part of the unmanned rotorcraft under the command and control of the Joint Logistics Support Group (JSLG) to manage their theatre-wide use effectively, while at the same time reducing the planning burden of the deployed FBRC units.

Against the background of the Future Operating Environment (FOE)[10], it would make a lot of sense if the FBRC unit(s) were stationed at one or more FOBs at relatively far distances from immediate threats and enjoying the support from other units and services partaking in the operation, while at the same time minimizing their logistic footprint. Co-locating the FBRC units with their supported combat units would allow the FBRC units to rely on them for force protection and other services. At the same time, it would facilitate planning, rehearsal, and execution of the mission tremendously.

Out of these FOBs, a number of well-defined mission types need to be synchronized with the overall battle rhythm and de-conflicted with other airspace users. The numerous routine resupply missions, mainly flown by the larger unmanned transport rotorcraft, would represent a large portion of the daily movements. MEDEVAC and QRF 24/7 stand-by missions would also be organized out of the FOBs, but the unit(s) should be prepared at all times to push these dedicated assets towards Forward Operating Locations (FOLs) either temporarily or for the whole engagement period to reduce intervention times. Finally, whenever in direct support of a specific operation, the FBRC will need to gather the required assets on the FOBs and FOLs to support task forces with their insertion, extraction, emergency resupply, and in close cooperation with other providers, the required SA and FSp.

Chapter Interoperability – Key to Mission Success

From the two above described lines of capability development, it is only a small step toward the next one. 'Interoperability' will, even more than today, be key to mission success. As underscored by the JAPCC, interoperability in operations is so much more than just standards for communication; it is about preserving the ability to work together.[11] Interoperability is more than the flawless exchange of information but must also include a very high degree of commonality in equipment and consumables as well as tailored tactics, techniques, and procedures. Indeed, it also refers to the education and training required to fully understand the mission, capabilities, and limitations of all the participants within the operation. In the pursuit of maximum interoperability, absolute priority should be given to the direct clients of the FBRC, being the supported combat units. Equally important however are the force multipliers such as the manned and unmanned combat aircraft as well as the force enablers such as Air-to-Air Refuelling assets.

To achieve this, attention should be paid from the start of the development process to keep the different rotorcraft variants as similar as possible with regard to the design of sub-systems and components. This principle should not be limited to the different versions of the same rotorcraft model, e.g. the 'medium-sized' transport and combat rotorcraft, but equally to the lighter and heavier rotorcraft within the same family. Obviously, this will not be possible for all parts of the platforms such as propulsion and transmission trains but should be feasible for almost every other part of the weapon system.

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The AH-1Z 'Viper' and UH-1Y 'Venom' share 84 % of parts commonality.

An even bigger issue is the preservation of interoperability between the FBRC and the legacy platforms they will operate within deployed operations. Even though some of these legacy platforms may have received a mid-life-update, serious differences in performance are still to be expected. These differences can be technical, such as speed gaps of up to 75 %, or technological, such as incompatible communication systems. There will be no easy solutions, and the end result might well be that for the planning and execution of certain missions, only one family of assets will be used to circumnavigate irreconcilable interoperability gaps.

Outlook and Conclusions

Considering the completely different design features of both JMR-TD contenders (the SB>1 Defiant and V-280 Valor); the future operating environment, which could vary from mountainous wastelands to littoral megacities; and the large diversity in future missions for the FBRC, it is likely both designs will be further developed. The author's previous statement that a 'one-solution-fits-all' would be very unrealistic for the FBRC has recently been affirmed by the director of the FVL program stating that 'a single aircraft design can't replace the Army's entire helicopter fleet'.[12]

The first steps towards a Future Battlefield Rotorcraft Capability have been taken, but there is still a long way to go before we witness Full Operational Capabilities in deployed operations. Technology is a powerful driver of this process, as will be demonstrated in the near future by the two JMR-TDs that are reaching maturity. However, it should be clear to all stakeholders that user requirements, military effectiveness and efficiency, and affordability should be equally if not more important drivers to be taken into consideration when closing the contracts and creating production lines. ●

1. Schoepen, W. 'Future Battlefield Rotorcraft Capability. Part 1: Analysing the Future Operating Environment'. In JAPCC Journal Edition 24, 2017, p. 28–32.
2. Schoepen, W. 'Future Battlefield Rotorcraft Capability. Part 2: Analysing Future User Requirements'. In JAPCC Journal Edition 25, 2017, p. 40–47.
3. Within the context of these articles, the term rotorcraft will cover all types of aircraft that have helicopter-like flight profiles regardless of the lift and propulsion system they use. Consequently all types of contemporary lift and propulsion systems such as single rotor helicopters (e.g.: UH-60), twin counter-rotating intermeshing rotor helicopters (e.g.: K-MAX), twin counter-rotating co-axial rotor helicopters (e.g.: Ka-52) or counter-rotating tandem rotor helicopters (e.g.: CH-47) as well as tilt rotors (e.g.: MV-22) or any kind of future or even futuristic types of propulsion that are yet to be developed fit this description.
4. Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities, and Interoperability.
5. Costello, M. 'Aerial Reconfigurable Embedded System (ARES)'. Available from https://www.darpa.mil/program/aerial-reconfigurable-embedded-system [accessed 12 Feb. 2018].
6. SB>1 'Defiant': available from https://www.lockheedmartin.com/us/products/sb1-defiant.html?_ga=2.23069369.2020484587.1519203210-2059852828.1518527886 [accessed 21 Feb. 2018].
7. V-280 'Valor': available from http://bellhelicopter.com/military/bell-v-280 [accessed 21 Feb. 2018].
8. Ibid 2.
9. Department of the (US) Navy, Research, Development & Acquisition. Available from http://acquisition.navy.mil/programs/air/ah_1z [accessed 13 Feb. 2018].
10. Ibid 1.
11. Joint Air Power Competence Centre (2014). 'Future Vector Part II'. Kalkar, Germany.
12. Robson, S. 'One size won't fit all for Army's future helo fleet, official says'. Available from https://www.military.com/daily-news/2018/01/04/one-size-wont-fit-all-armys-future-helo-fleet-official-says.html [accessed 22 Feb. 2018].

Colonel (GS) Wim Schoepen

joined the Belgian Defence in 1990 after having completed his academic studies at the Royal Military Academy. He received his helicopter pilot wings in 1992, became an instructor pilot in 1996 and cumulated more than 3,000 hours through different assignments in training units and operational squadrons. His operational experience started in 2000 with operation KFOR and has grown over the years with multiple EUBG, NRF and VJTF commitments. Additional staff and academic assignments have given him a solid background in education, training, operations, doctrine and policy. He also has a keen interest in strategic security and defence issues. He joined the JAPCC in 2016 as a Subject Matter Expert on Helicopter Operations.

An A-10 Thunderbolt II (nicknamed 'Warthog' or 'Hog') conducts a show-of-force manoeuvre. Having entered US Air Force service in 1976, the A-10 is the only production-build aircraft that was solely designed for Close Air Support.

Close Air Support of the Future

Is the Present Concept Still Adequate?

By Lieutenant Colonel Andrea Olivieri, ITA AF
By Lieutenant Colonel Michele Ferrari, ITA A. Avn.

Introduction

After the International Security Assistance Force (ISAF) mission and Operation Enduring Freedom (OEF) in Afghanistan, many of the Tactics, Techniques, and Procedures (TTP), as well as Lessons Learned/Lessons Identified (LL/LI) evolved within permissive air environments. Indeed, in the past 20 years, the vast majority of NATO operations involving air power have enjoyed Air Superiority or, in some cases, even Supremacy. Because of this, NATO's Close Air Support (CAS) and Joint Terminal Attack Controller (JTAC) capabilities have matured along these lines.

However, within the last four years the strategic geopolitical scenario has rapidly and dramatically evolved with the re-emergence of near-peer adversaries. This shift includes a growing hybrid-warfare paradigm and emerging Anti-Access/Area Denial (A2/AD) environments. Tellingly, the 2014 Wales[1] and 2016 Warsaw[2] NATO Summits highlighted various shortfalls within the Alliance such as CAS and Precision Guided Munitions (PGMs).

CAS evolution has always been dependent on technological developments, and it will undoubtedly continue to evolve as technology improves. However, how all three Services will carry out Close Support to ground forces will require solutions and methods that are more than mere technological improvements. So, what is the role of Close Air Support in the future battle and does it still hold a place in an ever more complex scenario, within a contested environment, and projected against a peer or near-peer adversary? And is 'Air' the only way Close Support will be delivered?


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Driving Factors

Air Superiority/Supremacy has not been a major concern for NATO Air Power in Kosovo, Iraq, or more particularly, in Libya and Afghanistan. Ground forces had a psychological benefit in knowing that a persistent presence in the sky was ready to 'immediately' intervene if needed. When troops became engaged ('in contact') with the enemy, a competent Tactical Operating Centre (TOC) alerted the Air Component for the necessity of CAS. Most of the time an asset was already available in the air nearby, or just above, those troops.

Nonetheless, the international political strategic environment has changed rapidly in the past four to five years, accompanied by 'new' emerging threats. Terms such as 'Hybrid', 'Asymmetric' and 'Urban warfare', as well as 'A2AD Environment' have saturated various think papers, studies, and articles from various international agencies and services to describe the new climate. At the same time countries within the Alliance have had to struggle with budget cuts which affected their national defence capabilities and contributions to collective defence. In effect, NATO is faced with new realities and challenges, most of which involve highly contested operations. As reflected in the outcome of the 2014 and 2016 Summits, the Alliance has had to admit that something has to change, in regards to funding and capabilities, so as not to be found unprepared for the next potential battle.

Developing and implementing improved CAS technology is one effort that may enable preparation for this future battlespace. However, the evolution of technology within the CAS community has been inconsistent at best and the introduction of new CAS technologies have not been without difficulties. The challenge of providing reliability and accuracy in environmentally austere environments has often given rise to scepticism and resistance to new ways of providing CAS. In general, changes to operating procedures are not always accepted and implemented without pain by the Services throughout the Alliance, where tried and true tools such as the consolidated 'nine-liner'[3] are well-known, and therefore psychologically palatable to soldiers and airmen. On the other hand, it is clear that modern systems evolution can help streamline CAS processes and produce better results.

Additionally, the Alliance must make better use of its current training capabilities to continue to provide robust CAS training. 'Live' flying hours are very costly and are becoming increasingly scarce in the context of shrinking conventional force structure. Real life assets

The Hungarian Air Force decided in 2017 to overhaul its twelve obsolete MI-24 attack helicopters. The Russian made MI-24 is a large helicopter gunship and attack helicopter with the NATO reporting name 'Hind'.

are increasingly less available for training due to two main factors: first, most available CAS assets are already employed in operations and second, a lot of CAS aircraft and equipment are reaching their end of service life without timely replacement. Therefore, the use of training tools such as simulators and other high tech equipment is imperative to prepare our aircrews and troops for future contingencies. Indeed, any resistance to innovation has to be put aside. Practically speaking, nations cannot afford to carry out training without CAS simulators and pooling and sharing of resources. Of particular note is the need to conduct training sessions with partners by networking their facilities and making them available to others within the Alliance. Only by sharing resources and training will we be prepared for the next fight.

Finally, the decreasing availability of pure CAS air assets not only affects training, but is being felt in decreased operational capability as well. For this reason, absent a large aircraft recapitalization effort across the Alliance, it is apparent that other joint capabilities are going to need to be integrated into close tactical support of ground troops. Perhaps it is time to consider shifting our paradigm from Close Air Support to Close Joint Support.

The Promise (and Problem) of Future CAS

At present, one of the leading concerns of the CAS community is the transformation of CAS provided primarily by 4^{th} generation aircraft to CAS delivered by 5^{th} generation air assets (and future 6^{th} generation). While similar paradigm shifts occurred when NATO transitioned from 2^{nd} to 3^{rd} to 4^{th} generation aircraft and with the advent of the data-link, the introduction of 5^{th} generation aircraft, combined with technological advances and shrinking conventional inventories, may catalyse brewing changes to CAS information and Command and Control (C2) nodes.

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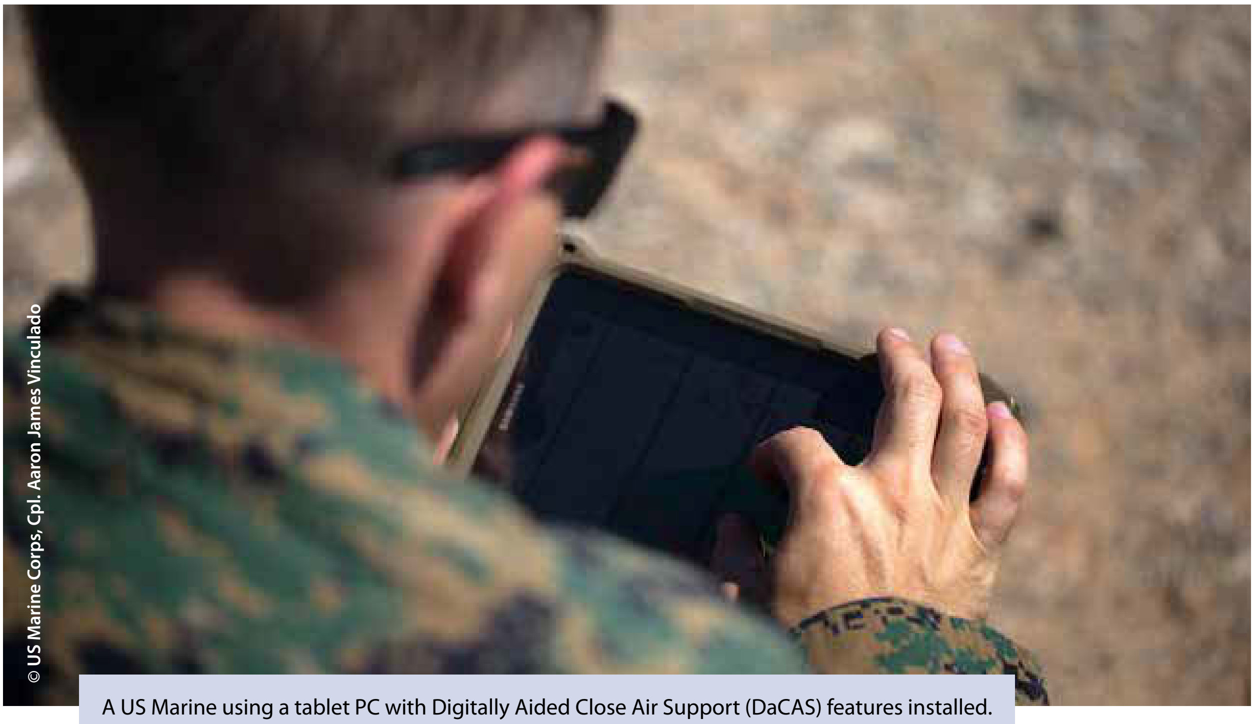
An Italian Tornado carries two GBU-39 Small Diameter Bombs. These multipurpose, penetrating bombs can hit targets from extended standoff range with high accuracy and minimal collateral damage.



© US Marine Corps, Cpl. Aaron James Vinculado

A US Marine using a tablet PC with Digitally Aided Close Air Support (DaCAS) features installed.

It is evident that the introduction of 5th generation assets into operational service is going to shift the *'modus operandi'* at the tactical and operational levels and will provide new opportunities to the command chain. For example, due to fewer tactical fixed-wing aircraft but increased data sharing among more capable platforms the use of Forward Air Controllers-Airborne (FAC/A), Unmanned Air Systems (UAS) and Airborne Battlefield Command and Control Centre (ABCCC) in Close Support will likely be more active, useful and necessary. Consequently, there will be a need to better define this evolving paradigm in publications and TTPs.

Rotary Wing will also play a vital role in the future CAS battle, especially when it comes to urban environments. The increasingly urban nature of warfare is creating a problem-set unlike much that the Alliance has faced over the last 25 years. In this environment, it will be necessary to have high mobility and manoeuvrability, plus robust communications relays.

This future environment will likely include a robust and resilient C2 'net', capable of supporting CAS enablers such as Digitally Aided CAS (DaCAS)[4]. DaCAS promises to enable crews/JTACs to link systems and weapons to ease and speed up CAS processes to have a better understanding of the battlespace and improved results with fewer steps. However, it has to be emphasized that not all Nations will acquire such technology in the near future and therefore there likely will be a capability gap. It will be imperative to strive towards a common picture and investment implying collective, multi-level (cross-Service and cross-Nation) will, an ability to trust one another, share data and prioritize operations in accordance with the available assets. A cohesion that transcends and elevates past the purely Military sphere.

Future Weapons/CAS Enablers

Of interest to various military communities, including the CAS community, are ongoing developments in the field of advanced weaponry; for example, in the fielding and perfecting of hypersonic projectiles fired by 'Railguns'. Railguns are devices that use electromagnetic force to launch projectiles with velocities in excess of Mach 5, using a sliding armature that is accelerated along a pair of conductive rails. Normally, the projectile does not contain explosives but relies on speed-related kinetic energy to inflict damage. The absence of explosive propellants or warheads to store and handle, as well as the low cost of projectiles compared to conventional weaponry, gives an advantage to the handler of the weapon. The speed, range and responsiveness of the weapon could prove key to providing future Joint 'close' fires, especially in contested areas that are difficult for aircraft to reach.

Furthermore, studies continue into the introduction and growth of Network Enabled Munitions (such as already existing SDB II Small Diameter Bombs) which can be reprogrammed in flight, hence giving more flexibility and prioritization in real time. Similarly, there are already some programs in the US for munitions which will fly in swarms. In the near future, there will be the introduction in service of Directed Energy Weapons (DEWs). These systems use DE primarily as a direct means to damage or destroy adversary equipment, facilities, and personnel through the emission of highly focused energy.

The Need for 'Jointness'

In certain environments (with a non-near-peer adversary) current concepts of 'permissive environment CAS' could still apply. However, against a near-peer opponent in a heavily contested environment, the contemporary approach to CAS will need adjusting.

In a highly contested A2AD scenario, presence and/or persistence of air assets will not necessarily be allowed. Traditional CAS assets with long loiter times and large ordnance capacities, but relatively low airspeeds and limited defensive systems, may not survive in such environments. Conceptually, much of the air effort will be directed against opponent fighter waves, enemy C2 facilities and surface-based Air Defence installations.

In this environment, multiple, simultaneous Troops in Contact (TICs) will be daily occurrences. If the 'A2/AD' environment is challenging enough, very few legacy aircraft will be able to support these TICs directly. This

The 5”54 caliber Mk 45 lightweight gun is a modern US naval artillery gun designed for use against surface warships and aircraft and for shore bombardment to support amphibious operations.

will dictate a priority of intervention and force Services to use all of the assets at their disposal. In other words, the required support will arrive by various methods and means, not all of which will be from the air component (e.g. naval and artillery fires). While this is not a new concept, the range and precision of Joint fires have increased dramatically over the last two decades. Coupled with increased/robust targeting information from new and improved sources (e.g. F-35), the reality of transforming the way we deliver fire support to engaged ground forces is within our grasp.

Conclusions, Recommendations and Possible Solutions

AJP-3.3.2.1 and ATP-63 define Close Air Support as: *'air action against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces.'*

In fact, the characterization of the future battlespace begs intriguing questions within the CAS community:

- Is the Term 'Air' still totally adequate in the CAS name and definition? (I.E. does the 'Air' only imply support delivered by aircraft?)

- Should an 'Air only' concept evolve to a cross-Service/Domain vision? (E.G. with Joint fires/indirect fire)

Today's equipment, assets, TTPs and Training have to evolve and become standardized across the Alliance to face the technological and conceptual changes of the future. This is because resources are fewer in numbers and more expensive and their use has to be optimized for a better result. So, in a slight deviation from the classic saying, 'Train as you *will* fight and fight as you *have* trained.'

The components have to accept the fact that the Close Support mindset has to radically change from an air-only intervention to a cross-service/multi-domain concept (eventually to 'All Domain') to counter the future challenges in the modern battlefield. Evolved threats will not allow our crews to operate in total freedom as they used to. Because it will still be imperative to provide Close Support where and when it is needed as fast and as accurate as possible, a drastic change in doctrine and CAS TTPs will be required. Not only must we teach our personnel the importance of joint thinking, we must also institutionally change how we train and operate together. It goes without saying that such a radical change will have epochal consequences and implications on the C2 environment.[5]

Ultimately, it is inescapable that the future battle should transform from a cacophonic mesh of single service fights, with a marginal consideration for sister components, to a unified, truly joint fight.

'The required support will arrive by various methods and means, not all of which will be from the air.'

Author's Note: The JAPCC is in the process of publishing a study which will further outline a vision of the future of CAS which will draw from previous lessons from other JAPCC studies but including the concept of Alliance assets as a system of systems. The study, among other things, will explore the ideas of transforming Close Air Support to Close Joint Support and shifting from close control of specified assets to an effect-based request system within a Joint effort.

1. Wales Summit Declaration, 16 Sep., 2014.
2. Warsaw Summit Communiqué, 9 Jul., 2016.
3. The 'nine liner' is the short name of the standardized format to be used by JTAC/FACs to fill-in required details of the CAS request to be transmitted to the employed aircrew.
4. See JAPCC study 'Air Warfare Communication in a Networked Environment', JAPCC 2017.
5. Implications for C2 will be addressed in the study 'Reshaping Close Support', to which this article is a lead-in.

Lieutenant Colonel Andrea Olivieri

joined the Italian Air Force in 1989 and is a qualified Navigator and Tornado Weapon System Operator. He participated in the US Air Force Student Undergraduate Navigator Training program in Randolph AFB (Texas) and subsequently graduated at the Tri-national Tornado Training Establishment in Cottesmore (UK). As an aircrew with 154 Sqn, he participated in the flying Operations in Bosnia and Kosovo and the Ground Operations in Iraq. Between 2007 and 2014, he served as Chief Current Operations in the Italian Air Operations Centre in Poggio Renatico and contributed, as an ATO Coordinator, to the Operation Unified Protector in Libya. He is currently stationed in JAPCC – Kalkar, as a Precision Guided Munition Expert.

Lieutenant Colonel Michele Ferrari di Valbona

joined the Italian Army in 1989, trained first as an anti-tank infantry officer in the anti-tank company of the grenadier brigade. After three years he transited to the Army Aviation schools and graduated as a fixed-wing pilot in 1994. As an aircrew assigned to the school he operated as observer pilot for the artillery fires. In 1997 he transited on twin engines planes and assigned to the 28^{th} Sqd.Gr. where participated in flying operations in the Balkans and ground operation in Lebanon. He served in the Balkan CAOC and as chief current OPS in the Army Avn School and as chief Ops at the 28^{th} Sqd.Gr. He is currently stationed in the JAPCC – Kalkar, as the Air to Ground integration expert.

SEAD Operations of the Future

The Necessity of Jointness

By Col Joseph Speed, USA AF, JAPCC
By Lt Col Panagiotis Stathopoulos, GRC AF, JAPCC

Introduction

Destroying or disrupting an enemy's air defence has long been central to any air campaign because it enables friendly air superiority/supremacy that protects friendly forces and allows freedom of movement. Without effective Suppression of Enemy Air Defence (SEAD), all other joint activities in a campaign carry a higher degree of risk. Historically, 15 % to 30 % of total flown sorties are tasked to conduct SEAD missions.[1] SEAD is essential to the core roles of Joint Air Power, supporting the strategic effects of deterrence, prevention, and defence[2]. These effects can be destructive (lethal) and/or disruptive (non-lethal).

While the capabilities and intensity of enemy air defences have varied greatly over the last 50 years, combat aircraft losses due to enemy air defences have been extremely low in recent conflicts. Though Alliance SEAD platforms are not solely responsible for this favourable trend, it is clear that SEAD is an important contributor to aircraft survivability[3].

However, the largely permissive environments of Iraq and Afghanistan have lulled the Alliance's planners into overlooking a burgeoning problem: a new generation of increasingly sophisticated and capable enemy air defence threats that threaten to overwhelm NATO's current SEAD abilities. The emergence of new traditional and non-traditional threats, such as very long range Surface to Air Missiles (SAMs), low observable air platforms, and cyber domain actors are

© Hellenic Air Force/Eagleaviation, Ioannis Lekkas already creating more complex and robust air defence systems. The question becomes: is NATO prepared to handle current air defence threats, let alone emerging ones? To answer that question, we must understand what SEAD is and is not. And to do that, we must understand where we came from, where we are, and where we are going.

SEAD Evolution

Electronic Warfare (EW) applications in operations were established in the early 20th century for communication and aerial target detection. Electromagnetic operations in the battlefield evolved rapidly between and during the two world wars[4]. Early warning radars and primitive air defence systems were developed during WW II, and particular countermeasures, such as chaff, were employed against these systems. During the pre-Vietnam war era, both eastern and western military forces shaped EW as a war fighting domain, while an early Command and Control (C2) system of air defence was also established.

The Vietnam War could be considered the watershed of systematically suppressing an enemy air defence.[5] The North Vietnam Army had an established Integrated Air Defence System (IADS) dedicated to the denial of 'blue' freedom of air operations. Specific air platforms, anti-radiation air-to-surface weapons, electromagnetic effectors (e.g. jammers), and specific suppressive tactics were employed by US forces to suppress the Vietnamese IADS. In effect, the war in Vietnam was the catalyst for what would become known as SEAD, and also highlighted the value of effective SEAD in contested environments.

The post-Vietnam war era saw the development and employment of advanced Anti-Radiation Missiles (ARMs), specialized EW assets, and new air tactics for SEAD operations. In response, adversary IADS complexity evolved to complicate SEAD targeting and provide resilience to air defence systems. Indeed, the last 30 years of air campaigns, such as Libya in 1986 (and 2011), the Persian Gulf War in 1991, Bosnia in 1995, Kosovo in 1999, and to a lesser extent Iraq in 2001 and 2003 – stand as testament to increasingly complex

Hellenic F-16 carrying AGM-88s (HARMs).

IADS and the necessity of effective SEAD air operations as a key enabler during the campaigns.[6] Much of the success of recent SEAD operations is due to the ability (and willingness) of Allied forces to address IADS in a somewhat flexible and holistic manner. For example, while it is not unusual for SEAD forces to employ anti-radiation missiles for the lethal suppression of enemy IADS assets, such as SAM Systems and Anti-Aircraft Artillery installations, forces have traditionally combined SEAD assets with EW platforms and tactics to support the suppression of the enemy IADS in a non-lethal manner, as well.

While there are successes in the SEAD arena, there are also misconceptions that may inhibit effective SEAD. For instance, many planners believe that SEAD = ARM (only), and that this wonder weapon suppresses every air defence threat. It does not take long to see the fallacy of this thought.

In Kosovo, despite the fact that Alliance SEAD operations made up 12 percent of total combat sorties,[7] Serbian IADS assets adapted their tactics to balance lethality with survivability, and therefore, they remained resilient and mostly operational throughout the conflict.[8] NATO assets launched over 750 ARM weapons[9], with very few achieving lethal effects against Serbian IADS assets.[10] Though suppression of the enemy air defence was eventually achieved, this was largely because Serbia was fighting with what could be considered inferior air defence assets and with limited support.

The need for increased SEAD operation 'jointness' was evident during the Libyan campaign in 2011, in which the suppression of the enemy's IADS may have been accomplished, but not solely by traditional SEAD assets.[11] For instance, attack helicopters based offshore were flying missions to strike radar sites, often in coordination with fixed-wing aircraft.[12] Similarly, Libya regime military hard targets such as radars, missile launch sites and communication nodes, were struck by sea-launched cruise missiles.[13] While the weapons the Libyan forces used were aged and less capable than those from near-peer competitors, the Libyan IADS was non-traditional.[14] Libya's IADS often used non-military infrastructure for Command, Control, and Communications (C3), which complicated targeting because of political and humanitarian concerns. For example, it used civilian air traffic systems to cue military IADS and incorporated modern commercial technology to counteract traditional SEAD targeting. Apart from the civilian infrastructure of the Libyan IADS, the urban Libyan territory, with its inherent potential for collateral damage, illustrated one of the many problems of using mainly ARMs to solve all SEAD problems.

A mere three years later, a resurgent Russia drastically changed the face of potential conflict in Europe and brought with it a host of interwoven air defence threats, most of which the Alliance had neither prepared nor practiced for. New, long-range (i.e. 'double-digit') SAMs, integrated and redundant command and control networks, 'bastions' of overlapping weapons engagement zones (WEZs) and an ability to orchestrate defence across multiple domains have drastically changed the SEAD environment. The term 'Anti-Access/Area Denial (A2/AD)'[15] has quickly become part of the SEAD lexicon. Indeed, merely shooting ARMs and hoping for the best will not do in this new environment.

The recent changes in the threat environment have brought the Alliance back to the SEAD drawing board, with a realization that our current SEAD capabilities may be inadequate for looming threats. There is a burgeoning realization that we must use all of the 'joint tools' at our disposal to address the threat.

SEAD Jointness – Back to the Future

The takedown of the Iraqi IADS in 1991 was indeed a joint affair, and it was an example of what is possible when we are willing to use all of the joint tools at our disposal.[16] The coalition used air, land, SOF, and naval forces to degrade, destroy, and suppress the enemy's air defence using a variety of weapons and effects. This joint approach to take down the Iraqi IADS, and subsequent support to SEAD, was a high point of thought and cooperation. However, the intervening years have seen dwindling SEAD assets and fissures in jointness. Additionally, while the Iraqi air defence was formidable, it pales in comparison to what the Alliance faces today.

Considering the core capabilities of potential NATO adversaries[17, 18], it is apparent military threats are evolving towards a more 'command-centric approach'. Also, technological innovations such as low observable and unmanned systems, advanced linked-communication, robotics, virtual reality, cyber, information, space, advanced computing power, biomimetic,[19] and easy to access commercial-of-the-shelf (COTS) products are being employed by armed forces. Future battlefields will unmistakably be a complex, asymmetric environment.

Recent simulations and operational level exercises against bastions of 'A2/AD' demonstrate joint effects are crucial for success. No longer can one service expend a few high-value weapons and expect to operate with impunity. Various wargames have demonstrated the possibility of severe losses if the military components do not plan and execute a genuinely joint plan. Every branch and domain must operate in coordination to achieve the campaign goals. In other words, jointness of SEAD operations is a prerequisite for every future NATO campaign. Considering current NATO military competencies, the two main categories (kinetic and non-kinetic) may be addressed to describe currently available SEAD capabilities.

Kinetic SEAD capabilities may be described as an activity in which forces employ lethal munitions or weapons towards the suppression of enemy air defence. While specific air platforms have been developed to employ SEAD weapons, various assets can contribute effectively to the SEAD mission with a multitude of resources. Aside from ARMs, Stand-off/Cruise Weapons (SOW), Joint Direct Attack Munitions (JDAM), Direct Attack to Surface Missiles and Anti-Ship Missiles (ASM) may be employed by a variety of air power platforms against enemy air defence targets in accordance with operational constraints. Also, certain land, sub-surface and surface-based systems can launch kinetic weapons against air defence components. Finally, Special Operation Forces (SOF) may be employed to sabotage or destroy an adversary system which may support an IADS.

Conversely, any set of activities employed in the electromagnetic spectrum to deny, neutralize, disable, or disrupt hostile electromagnetic operations

Successful land operations depend on effective SEAD.

and suppress an enemy air defence can be considered as non-kinetic capabilities of EW in support of SEAD operations. An IADS is a complex system that not only consists of emitting radars, surface-to-air missile systems or air defence aircraft but also communication systems/nodes and data links. Both industry and the military have developed weapons which can produce effects on the adversary's electromagnetic spectrum capabilities (i.e. C3 networks). Current examples include the use of the EF-18 Growler, the EC-130 Compass Call and experimentation with directed energy weapons.

Lastly, airborne decoy systems may contribute efficiently to SEAD operations. For example, a Miniature Air-Launched Decoy (MALD), which might be a small jet-powered aircraft appearing like a full-size aeroplane or a cruise missile, may trigger the enemy air defence system if it is flying in the SAMs' effective ranges. As a result, this may lead to dissipation of adversary SAM ammunition stocks. Even more importantly, the details of the enemy's air defence systems may be recorded and critical nodes subsequently targeted by SEAD forces. In effect, even though decoys may or may not employ a direct effect on an enemy air defence system, these systems can collect valuable information on enemy IADS and enable lethal or non-lethal SEAD courses of action.

Putting It All Together

The Alliance has various kinetic and non-kinetic capabilities that can be used for SEAD. Aside from the weapons, the awareness and willingness to address threats from a joint perspective is the last piece of the puzzle. Efforts are currently underway in NATO to educate the joint community about the latest air defence threats and what will be required to survive and thrive in a potentially dangerous environment. While not a panacea for all that ails the Alliance, this education is already beginning to show dividends through a resurgent joint mindedness, especially in regards to SEAD.

Potential adversaries' military technology transformation and the continuously developing A2/AD capabilities

Use of the entire joint team will be crucial to SEAD of the future.

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dictate that jointness will continue to be required during SEAD operations. SEAD is not just shooting an ARM, it is a core capability of Alliance joint power (not solely air), in which air and surface, and even space or cyber operations, should be executed jointly for effective suppression of air defences. Therefore, it's not enough to simply put joint capabilities in the same mission set, but you also need an agile way of commanding and controlling them. Consequently, NATO should consider developing C2 procedures that enable Joint SEAD operations to be effectively directed in accordance with operational domains' activities, demands and restraints.

Even though many SEAD challenges are expected in the complex, asymmetric battlefield environment of the future, the first challenge is likely to remain jointness. Recent military campaigns demonstrate jointness is a perishable skill and requires careful thought and practice. In the end, while air defence systems may become more lethal and complex, the best weapon against them will be our willingness to work together. ●

1. Bolkcom, Christopher, 'Military Suppression of Enemy Air Defences (SEAD): Assessing Future Needs'. In Library of US Congress. Washington DC, 2005 [cited 24 Jan. 2005]. Available from www.dtic.mil; Internet.
2. Lt Gen Wundrak, Joachim, et al, 'Joint Air Power Following the 2016 Warsaw Summit: Urgent Priorities'. An Allied Command Transformation Headquarters Study conducted by the Joint Air Power Competence Centre. Kalkar/Germany, 2016. Online at: https://www.japcc.org/portfolio/airpowerafterwarsaw/
3. Ibid. 1.
4. Dr. Price, Alfred, 'Instrument of Darkness: The History of Electronic Warfare, 1939–1945'. London, 2017.
5. Wayne Thompson, 'To Hanoi and Back: The USAF and North Vietnam, 1966–1973'. Washington, D.C.: Library of US Congress, 2000.
6. Ibid. 1.
7. Lambeth, B. 'NATO's Air War for Kosovo: A Strategic and Operational Assessment'. Santa Monica: RAND Corporation, 2001.
8. Ibid. 7.
9. Stanisław, Czeszejko, 'Anti-Radiation Missiles vs. Radars', International Journal of Electronics and Telecommunications, Vol. 59, no. 3 (2013): p. 285–291. Manuscript received 2 Sep., 2013; revised Sep., 2013. DOI: 10.2478/eletel-2013-0034. Available from www.degruyter.com; Internet.
10. Lambeth, Benjamin, 'Kosovo and the Continuing SEAD Challenge'. In Aerospace Power Journal, summer 2002: p. 8–21 [cited 3 Jun. 2002]. Available from www.ausairpower.net; Internet.
11. Mueller, Karl, 'Victory Through (Not By) Airpower'. In RAND: Precision and Purpose, Airpower in the Libyan Civil War, edited by K. P. Mueller. Santa Monica: RAND, 2015.
12. Chivvis, Christopher, 'Strategic and Political Overview of the Intervention'. In RAND: Precision and Purpose, Airpower in the Libyan Civil War, edited by K. P. Mueller. Santa Monica: RAND, 2015.
13. Kidwell, Deborah, 'The U.S. Experience: Operational'. In RAND: Precision and Purpose, Airpower in the Libyan Civil War, edited by K. P. Mueller. Santa Monica: RAND, 2015.
14. Kassebaum, Jeff, 'The Art of SEAD: Lessons from Libya', Journal of Electronic Defense, Vol. 34, Issue 12 (2011): p. 58–62.
15. Schmidt, Andreas, 'Countering Anti-Access/Area Denial'. In: The Journal of the JAPCC, II (23). Kalkar/Germany, 2016: p. 69–77.
16. Brungess, James, 'Setting the Context, Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World'. Air University Press. Alabama, 1994.
17. US Defence Intelligence Agency (DIA), 'Russia Military Power'. [Electronic report]. Washington D.C., 2017 [cited 28 Jun. 2017]. Available from www.dia.mil; Internet.
18. US DoD Office of the Secretary of Defence, 'Military and Security Developments Involving the People's Republic of China 2017'. [Electronic annual report to Congress]. Virginia, 2017 [cited 15 May 2017]. Available from www.defense.gov; Internet.
19. Biomimetic means the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems (Vincent et. al, 2006).

Colonel Joseph Speed

graduated from Mississippi State University with a Bachelor of Business Administration Degree in 1992. He has served as an F-16 instructor pilot, flight examiner, flight commander and assistant director of operations. He also has served as a director of operations and squadron commander of flying training and support squadrons. He is a command pilot with more than 2,800 flying hours, including 353 combat hours, and was a SEAD Instructor Pilot in the F-16CJ. He is currently serving as the Combat Air Branch Head at the Joint Air Power Competence Centre.

Lieutenant Colonel Panagiotis Stathopoulos

graduated from the Hellenic Air Force (HAF) Academy with a BSc in Aeronautics in 1995. He holds an MSc in Human Factors and Safety Assessment in Aeronautics from Cranfield University, UK, and is a graduate of the HAF Tactical Weapons Fighter School. He is an F-16 instructor and functional check flight pilot, and he is still a command pilot with more 2,000 flying hours. He has also served as director of operations and as commander subsequently in the 341 Fighter Squadron from 2012 till 2016. He is currently serving as the Electronic Warfare (EW) including SEAD Operations SME at the Joint Air Power Competence Centre.

Beating Cold

Rotary Wing Operations in the Arctic

By Lieutenant Colonel Miklós Szabó, HUN AF, JAPCC

'NATO needs realistic training, where we can combine operations in the air, at sea and on land. In Norway we get everything, this is one of the best places to train in Europe … The cold climate also brings extra challenges for the soldiers that hones their skill.'

General Mercier on Exercise Trident Juncture 2018 [1]

Author's Note:

'Beating Cold' is a companion article to a piece previously published in the JAPCC Journal ('Beating Brownout'), that discussed rotorcraft operations in a degraded visual environment.[2] *If not considered, seemingly negligible circumstances can make the difference between a 'win' and a 'fail' in rotary wing operations. In this article rotorcraft operations in an Arctic environment will be put under the magnifying glass.*

Introduction

Although the Arctic region did not gather a great deal of attention from the public or the military in the last couple of decades, things have changed in recent years. Recognizing their modern advances in the area, it's evident that the Russian Federation considers the Artic a renewed strategic interest and worthy of deliberate engagement. The resurgence of old military[3] and scientific bases north of the Polar Circle, extensive development of infrastructural facilities and development of different sea-borne and air assets that are specifically designed to withstand extreme cold conditions mark their intention to reinforce and/or project power at their northern border, and beyond.

The area holds a significant portion of untapped oil and natural gas reserves, and it is the most abundant source of fresh water of the world. Strategically important sea lines of communication and fishing areas overlap the inner area of Arctic Circle. Being the most prominent territorial claimant in the region, Russia has intensified its activities and investments in the last few years. This has in turn energized the attention of 'neighbouring' countries (all five happen to be NATO nations[4]) towards elevating their presence and situational awareness in order to counter or balance the Russian advance.

Recent NATO strategic studies have stated that NATO has to be prepared to take actions practically anywhere in the world under various climate conditions.[5]

As a result, much emphasis is being put on the ability to conduct missions, with the support of helicopters, in extreme conditions like hot and high or desert environments. Arguably, it may also be wise to take a closer look at what the Arctic would look like as an area of operations, and the associated challenges to rotary wing support.

Rotorcraft – The Unmatched Mission Enabler

Due to their unique ability to reach practically any part of the battlespace many times faster than ground assets, helicopters can be used to support or conduct a wide variety of missions. These range from routine logistic resupply or MEDEVAC[6] missions to more complex tasks like the recovery of isolated personnel, tactical support of ground troops, supporting of special operations units, or detection of submarines. Because rotary wing assets are so integral to military actions across the services, they have to be reliable and available, despite whatever unfriendly climatic and geographical conditions an area like the Arctic would offer. When it comes to NATO, rotorcraft are needed quickly and in relatively large numbers to respond to potential/escalating situations. At the same time, establishing a sufficient number of rotary wing assets in a newly opened area of operation is always a long and challenging enterprise. This is especially true when it is necessary to satisfy special needs, such as operating in extreme conditions or contested environments at distant locations. So what are some significant factors NATO and member countries have to consider before deploying to the Arctic with helicopters?

Operating Rotorcraft in the Arctic

Once deployed to the Arctic, both personnel and equipment are often very exposed to the grim conditions. Logistic support, maintenance and flight operations may be challenged, first of all, because of the physiological effects of extremely cold temperatures, which reduces human performance by orders of magnitude.[7] Not only can the cold be physically debilitating, but the effects of the extreme northern latitude can provoke other changes in personnel. Over the course of the deployment, perpetual daylight – or the darkness even more so – may have deteriorating effects on the psychological and mental condition of personnel. Secondly, aircraft and servicing equipment also require special materials and handling in this environment. Unlike in some less-demanding climatic conditions, Arctic helicopters must be stored correctly, either in a hangar or covered. Appropriate and adequately handled fuel, special lubricants designed mainly for cold weather use, and durable batteries are needed to allow seamless start up and flight. To prevent ice accumulation on critical parts, such as rotor blades and engine intakes, as well as to avoid misting of windshields, optic lenses, weapon systems or sophisticated electronic equipment, effective pre-flight and on-board de-icing and heating have to be available.

From an operational aspect longer reaction times have to be considered both for pre-planned missions and readiness tasks such as MEDEVAC. Planning of the latter requires even more attention, taking the fact into account that longer reaction times, combined with the unforgiving nature of the environment, reduces the chances of survival of wounded personnel, suggesting careful reconsideration of the 'Golden Hour' rule[8].

Also, under cold weather conditions, troops are heavier, thanks to their winter gear and survival equipment. In some cases, this may necessitate reducing unit size on one aircraft or trading off useful load and fuel. In addition, troops move slower, and embarkation as well as debarkation may take longer than usual.

Flying is not any easier than doing other activities in the Arctic. As white-out conditions during manoeuvres close to the ground are likely to occur, air and ground crews have to be highly trained to overcome such situations safely. Helicopters should be equipped with systems that allow for safe operations when the visual environment is degraded. It's common to encounter featureless terrain with few, or practically no, references when moving towards higher latitudes, which can offer the feel of flying under IMC[9] in any season, especially during the half year-long night.

Adding to that, there are other peculiarities involved in navigating around the pole, be it visually or on instruments. The Earth's magnetic field is highly distorted. Because of ionization interference and the low elevation of positioning satellites on the Arctic horizon, it is fair to say that satellite-based navigation is not as accurate as it is south of the polar circle. While this can be mitigated by ground-based and/or on-board navigation equipment, it may mean that Doppler or inertial navigation systems (i.e. non-GPS) may become primary assets to get from point A to point B.

NATO's Rotary Wing Resources

As we recall how NATO's mission in Afghanistan started with regards to helicopters, we must remember that it took quite a while until the Alliance alleviated the primary discrepancies and reached a sufficient level of readiness and effectiveness of its rotary wing fleet.[10] In the beginning, it was not common practice for many contributing nations (which offered helicopters and their crews) to fly and land at the high altitudes found in the Afghan mountains or land in brown-out conditions common in the dry and dusty terrain. Likewise, some of the nations' assets were significantly restricted, simply incapable of, flying on hot summer days. With that in mind, it is worthwhile to review what NATO has, and what it does not have, on hand in case the Alliance's interests have to be protected in the high north.

When talking about resources, it is not only the sheer number of assets or personnel that have to be considered. Conducting sustained operations in the high north requires robust infrastructure and logistics. Assets have to be fit not only for the operation but for the ability to overcome environmental effects that are endemic in the Arctic. Air and maintenance crews,

both personnel and units, have to be trained to operate, and just as importantly, to survive and maintain physical and mental fitness during their deployment.

NATO's Potential to Operate in the High North

As was mentioned earlier, there are five NATO nations which have territorial interests in the Arctic; USA, Canada, Denmark, Iceland and Norway. Four of them (as Iceland does not have military forces) would likely constitute the first echelon of reacting forces if the situation necessitates. These four nations hold the most relevant knowledge and experience in the environment and their geographic locations allow them to react quickly. Generally speaking, all four countries have the right type of equipment and facilities available, and they regularly train, exercise and operate under cold and snowy conditions.

Additionally, while the United Kingdom does not have territories in the region, its forces have a long history of training and exercising there. For the last 48 years, the Joint Helicopter Command (previously: Commando Helicopter Force) has been deploying to RNoAF Bardufoss in Norway to conduct their ground Cold Weather Training and learn the necessary skills to fly and operate in the Arctic.

The list of nations would not be complete without mentioning two non-NATO partners who have extensive cold weather aviation experience, namely Finland and Sweden. Their regular cooperation in training and exercises with neighbouring Norway has established a robust repository of knowledge and experience.

Although for most of the other Alliance nations the Arctic looks to be outside of their sphere of interest, when we talk about deterrence and collective defence, they have their part to play, too. The good news is that many of these nations, especially those which have higher mountains with longer snow seasons, conduct varying levels of cold weather-related environmental training, including survival and flight training. Many nations' operators are familiar with Arctic-like conditions such as the detrimental effects of white-out or swiftly changing weather conditions. However, they may not be accustomed to midnight sun or polar nights[11], or the difficulties experienced when operations need to be sustained for a long time under such extreme circumstances. By leveraging the collaborative ability of the Alliance, as was indicated in a 2012 JAPCC study[12], even smaller nations can prepare for flying and operating under 'unusual' conditions, by partnering with countries where such training can be conducted. Consequently, exercises in appropriate locales should precede any sizeable rotary wing deployment.

An HH-60G 'Pave Hawk' and two UH-60 'Black Hawk' fly over USS Hampton (SSN 757) during Ice Exercise (ICEX) 2016.

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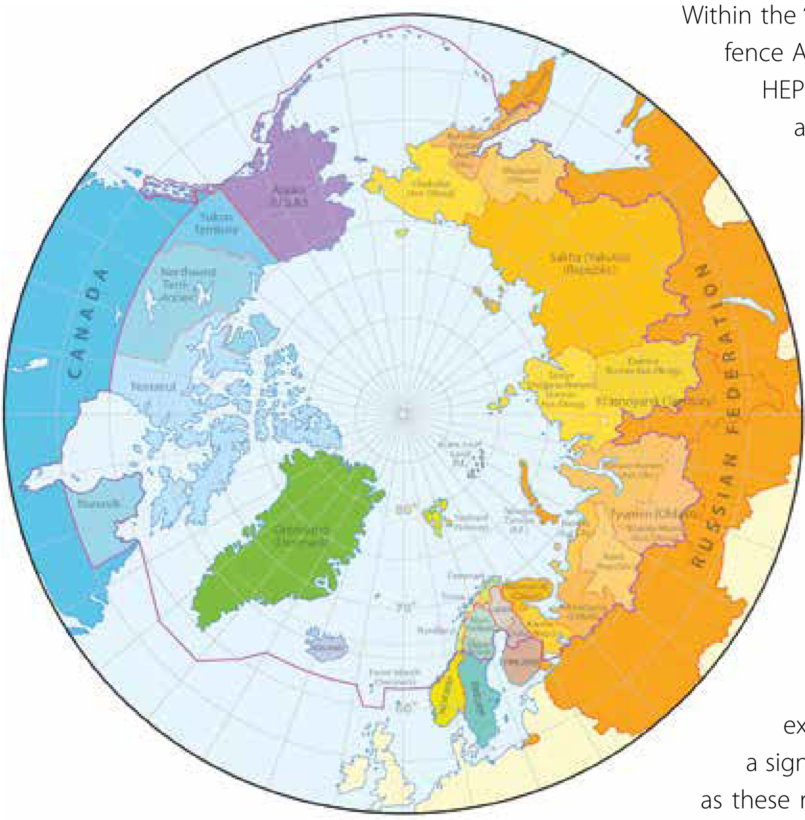


The Arctic Region. © Copyrighted

Rotary Wing Exercises

As an Alliance, we seemingly have all the Arctic rotorcraft puzzle pieces in hand, but the comprehensive picture still has to be realized through cooperation and training. Based on lessons from our recent past, we must recognize that rotorcraft involvement in large scale and/or sustained operations may require the contribution of other allied nations. Except for the US, no other nation has the dedicated assets to conduct the full spectrum of helicopter training and operations on their own[13]. It is fundamental within the Alliance that collaborative actions in the area of operations have to be preceded by common training and exercises. However, we have to admit that there is currently no such thing as a comprehensive 'NATO Helicopter Exercise', where knowledge among nations can be shared, interoperability is improved, and thus better operational capability is achieved. Nonetheless, there are some recent examples of rotorcraft exercises that NATO might consider emulating.

Within the 'Blade Series' Exercises the European Defence Agency Helicopter Exercise Program (EDA HEP) has dedicated helicopter exercises, usually based on different scenarios and organized in areas of Europe offering different environmental conditions. In the spring of 2016, Finland hosted the Cold Blade 2016 exercise providing the possibility to practice various tactical scenarios under cold weather conditions.

On an invitational basis, some of the Nordic nations open up their national exercises to allow other nations to practice with them, such as often happens with Norway's Joint Viking or Cold Response exercises. Although these particular events are not explicitly designed for helicopters, there is a significant participation of rotary-wing assets as these remain critical enablers of many kinds of operations. Likewise, Trident Juncture 2018, a large scale live NATO exercise, will also be held in Norway. Although these exercises give rotary wing crews a somewhat limited chance to train and operate together, they are the best that are currently available. Tellingly, many experts from the rotary wing community believe that helicopter-specific international exercises and/or establishing a training facility similar to the fixed wing community's Tactical Leadership Program, are the missing link(s) towards better performance of rotary wing forces.

Conclusions

Two decades ago, many of the NATO nations did not anticipate that in few years they would deploy to countries other than their homeland. Fifteen years ago many of the countries still did not realize that they would soon have to operate in desert or high mountains, facing challenges provided by flying dust, low air density and high temperatures. For most nations today, a scenario in which they would deploy to the Arctic seems unlikely. However, if the volatility of history is any gage, and keeping the NATO strategic

During Ice Exercise (ICEX) 2016, Ice Camp Sargo accommodated more than 200 participants from four nations.

guidance on worldwide, out-of-area mission capabilities in mind, nations have to be prepared to operate in this austere environment.

In the future, operating in the Arctic will likely be less and less the 'privilege' of Arctic nations. The good news for non-Arctic nations is that they do not have to start from scratch and that various skills can be practiced without actually travelling near the North Pole. For example, a significant number of NATO nations have been flying in a degraded visual environment or high mountains for a long time, and mountain (winter) survival training is within reach for most. In addition, some countries described earlier as 'the first echelon', have vast experience and a knowledge repository to share with others. However, what the Alliance desperately needs is a forum to share knowledge, improve interoperability and uncover hidden discrepancies, be it a school house or a series of exercises in general, but also with specific regard to Arctic operations.

With the past as our guide for the future, clear technical, training and capability requirements have to be laid down to avoid a repeat of the situation NATO faced when the Alliance took command over ISAF. Indeed, the Arctic is no place to start rotary wing operations 'cold'. ●

1. 'Preparing for Trident Juncture 2018: NATO Focuses On Its Core Mission.' Available at: http://www.sldinfo.com/preparing-for-trident-juncture-2018-nato-focuses-on-its-core-mission/ (Accessed: 15 Jan. 2018).
2. Cdr Maurizio Modesto, ITA N, JAPCC: Beating Brownout – Technology Helps but Training Remains Key.
3. Russia lifts veil on new Arctic military base, but secrets remain; https://www.arcticnow.com/voices/analysis/2017/05/05/russia-lifts-veil-on-new-arctic-military-base-but-secrets-remain/ (Accessed: 15 Jan. 2018).
4. USA, Canada, Denmark, Iceland, Norway, however Finland and Sweden (non-NATO) also have major interest in the region.
5. NATO Allied Command Transformation – Framework for Future Alliance Operations 2018.
6. Medical evacuation of wounded personnel.
7. Impacts of cold climate on human heat balance, performance and health in circumpolar areas (Accessed: 14 Feb. 2018, http://www.tandfonline.com/doi/pdf/10.3402/ijch.v64i5.18027).
8. 'Golden Hour' – MEDEVAC and advanced trauma care assets must reach the casualty within one hour of wounding.
9. Instrumental Meteorological Conditions.
10. Aviation Week Report: NATO Accelerates Search For More Helicopters For Afghanistan Operations (Accessed: 14 Feb. 2018, http://tonyprudori.pbworks.com/f/NATOPush4Choppers-AvWeek-25Nov07.pdf).
11. The midnight sun is a natural phenomenon that occurs in the summer months in places north of the Arctic Circle or south of the Antarctic Circle, when the sun remains visible at the local midnight. Polar night is the opposite phenomenon during winter, when the sun stays below the horizon throughout the day.
12. Enhancing NATO's Operational Helicopter Capabilities; JAPCC, Aug. 2012.
13. Ibid., p. 20, 4.2.6.

Lieutenant Colonel Miklós Szabó

is a 1989 graduate of the Hungarian Defense Forces (HDF) College of Military Aviation, holds a Master's Degree from Hungary's National Defense University, and is a graduate of the US Army Aviation Officers Advanced Course. He held different positions as an Mi-8/17 helicopter pilot, flight instructor and test pilot. He further served as unit flight safety officer, squadron commander, and commander of a transport helicopter battalion. He was a senior helicopter SME at the HDF General Staff, developing operational requirements for helicopter procurement and strategic concepts for military aviator training. His operational experience includes domestic disaster relief operations as well as an ISAF Mi-17 Air Advisor tour. He is currently the Helicopter SME of the JAPCC Combat Air Branch.

A demonstration on 22 April 2015 marked the first time in history that an unmanned aircraft (X47-B) had successfully been refuelled air-to-air.

Standardizing Automated Air-to-Air Refuelling

Considerations for a NATO Concept of Operations

By Steve McLaughlin, Naval Air Systems Command (NAVAIR)
By Mark Pilling, Science Applications International Corporation (SAIC)
By Phillip 'PD' Weber, Coherent Technical Services Inc. (CTSi)
By Ba Nguyen, Air Force Research Lab (AFRL)

Introduction

Researchers have been studying the possibility of refuelling aircraft without a human at the controls for nearly two decades. Finally, that research is coming to fruition. In 2007, an Automated Aerial Refuelling Demonstration (AARD) achieved a major milestone by conducting the first automated (piloted but 'hands off') engagement of a probe and drogue system.

That test was led by the US National Aeronautics and Space Administration (NASA), the Defence Advanced Research Projects Administration (DARPA), and their industry partners. Since then research and development efforts have continued via the US Air Force Research Laboratory's (AFRL) Automated Air-to-Air Refuelling (A3R) program and the NAVAIR X-47B A3R demonstration which culminated in the world's first contact between an automated unmanned aircraft and a manned tanker. The aircraft currently in development are automated as they fly a predetermined route based on a set of precise instructions. An Air Vehicle Operator (AVO), sits at a remote control station, monitoring the health of the aircraft, standing by to issue updates to its mission as needed, and acting as the pilot in command for the Unmanned Air Vehicle (UAV), or even a set of UAVs.

In this document two terms will be used extensively, Air-to-Air Refuelling (AAR) and A3R. AAR refers to the air-to-air refuelling pairing of two manned aircraft, where a pilot at the controls physically flies the contact. When either one or both of those aircraft is replaced by an unmanned or automated aircraft, the process becomes A3R, and the contact is made by a computer controlled flight trajectory.

Need for Standardization

As the US and other nations continue their research and development of Unmanned Aerial Vehicles (UAVs) capable of in-flight refuelling, an operational system is in the near future. The Joint and Allied community has spent decades working to standardize the AAR mission, which essentially boils down to a mechanical interface (boom mating to a receptacle or probe mating to a drogue). As the community moves toward making A3R a reality, more complicated control systems will be developed, such as relative positioning systems, data link systems, and remote AVOs. To achieve a level of interoperability comparable to that of manned AAR, we must begin the standardization process now.

Understanding this need, the international Aerial Refuelling Systems Advisory Group (ARSAG) created a working group to develop recommended A3R procedures. Over the course of three years, the team developed and submitted a draft Concept of Operations (CONOPS) to the NATO Air-to-Air Refuelling Working Group for consideration. Depending on national positions, it is conceivable that information from the CONOPS could be eventually included in the NATO AAR Allied Tactical Publication 3.3.4.2 (ATP-3.3.4.2).

A3R Conceptual Overview

In developing the draft CONOPS, the team had to arrive at a number of baseline assumptions. Since the idea of A3R might still be foreign to some readers, these assumptions were aimed at keeping the process basic, with the option to revise as system and process development matures. As such, the procedures currently address single receiver/tanker operations.

Manned AAR remains the baseline. The overarching assumption is that, to the maximum extent possible, A3R procedures will be designed to accommodate current manned AAR standards and procedures. Therefore, the A3R CONOPS utilizes ATP 3.3.4.2 as a basis while detailing the differences or additional requirements pertaining to A3R. Secondly, it is envisioned that the tanker/receiver pairing can be any combination of manned or unmanned aircraft. In the case of an unmanned Air Vehicle (AV), an AV's technical capabilities are assumed to include some degree of autonomy in that it can safely maintain flight and execute a manoeuvre by selecting from a finite set of pre-defined actions without supervision unless a human operator intervenes. In the case of manned aircraft, the aircraft may include capabilities to conduct automated refuelling, wherein the engagement process would be an automated task that the pilot would select and monitor as a safety observer.

AVO still in the loop. Until unmanned A3R CONOPS are better understood, a key operational assumption is that an AVO will be in the loop giving approval for the AV to proceed from one phase/position to the next. In this concept, the AAR process has been automated within each step but it is not a completely autonomous mission. In the future, A3R operations may make full use of autonomy and might need only one message to the AV: Tank. The AV will find the tanker, join, take fuel, depart the tanker and report tanking complete to the AVO. To get there, the concept of automated operations must be proven.

With the need for the AVO to approve the AV to move from one phase/position to another, it is important to highlight who has operational control of the mission in the air. For these procedures, the tanker aircrew, or

AVO in the case of an unmanned tanker, will retain control of the airspace around the tanker. The tanker crew/tanker AVO will command the receiving AV (manned or unmanned) through the tanking procedures while the receiver AV crew/receiver AVO responds to the commands, monitors the event, and maintains override authority. These commands will be relayed to the AVO, primarily through digital messaging over a data link, but voice commands may be used to communicate between tanker operator and receiver operator. This requires a datalink network be established between the tanker and receiver AV enabling the exchange of key navigation and command and control messages. This message content will fully define tanker type, precise position information, control messages, and datalink health status.

A3R Positions

With the premise of keeping A3R joining or rendezvous (RV) procedures simple, a basic RV procedure, RV Alpha, known to NATO crews and found in the ATP 3.3.4.2 was selected. RV is the process by which

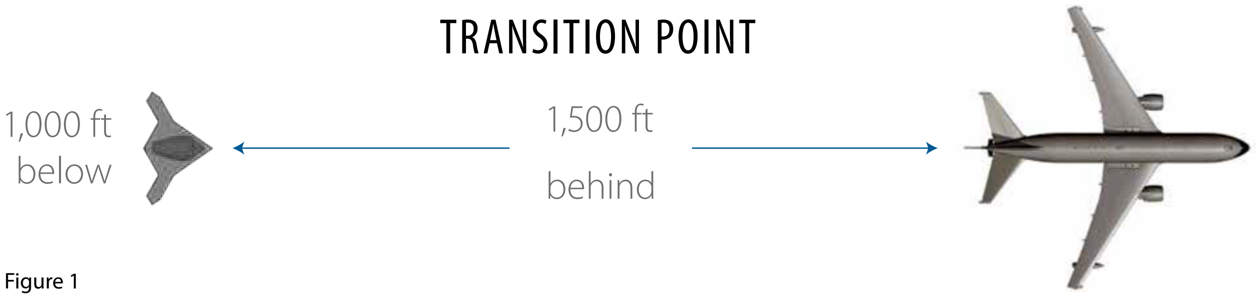
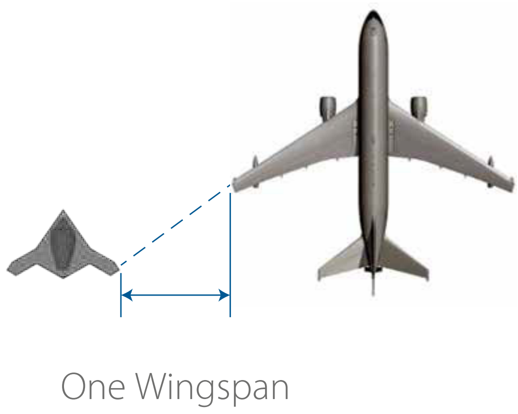


Figure 1

the tanker and receiver join-up to each other in flight prior to making contact and transferring fuel. RV Alpha was selected for A3R because of its flexibility and compatibility with unmanned operations. RV Alpha is based on an air traffic controller verbally providing flight vectors to a receiver to join on a tanker established in a holding pattern. Because the A3R navigation systems are installed on the tanker and receiver, they will know the precise location of each other.

Prior to beginning the RV, the tanker and receiver will ensure they are established in each other's network. When commanded by the AVO, the receiver's flight computer will act as the airspace controller in RV Alpha and will use the navigation data received from the tanker to fly the air vehicle to an intercept with the tanker at a new position known as the Transition Point (TP). The TP is 1,000 feet (ft) below and 1,500 ft in trail of the tanker (Figure 1). This allows the AVO to assess the AV's relative navigation performance prior to commanding the AV any closer to the tanker. Throughout the tanking operation, the AVOs or crew of the tanker and receiver will be able to monitor the position of each other and the messaging sent to each AV. When the AVO(s) is satisfied that the systems of the tanker and receiver are performing as required,



ECHELON LEFT / AWAITING A3R

Figure 2

Two 'Global Hawk' unmanned aircraft in pre-contact positions as tanker and receiver preparing for A3R. This was part of DARPA's KQ-X program investigating and developing automated aerial refuelling techniques.

© NASA, Jim Ross

The NASA 'Dryden' A3R project used a modified F-18 systems research aircraft for various tests. On 2 May 2007, the crew was hands-off when their F-18 flew its probe into the drogue during an automated refuelling demonstration.

the receiver AV can be commanded to depart the TP and proceed to either position in echelon with the tanker or astern of the contact position.

A3R Commands and Messaging

Since the goal is to seamlessly integrate manned and unmanned operations, A3R will be designed to use the existing standardized voice Command and Control (C2) messages and procedures that are translated into data link messages that an AV's computer can understand.

C2 messages could be identified as originating from the tanker or receiver. Using this philosophy, and the process described above for control of the AVs as well as the surrounding airspace, a message set could be established to cover all operational scenarios. For example, the tanker could send the command *'Cleared to Tanking Position X'* where *'X'* is an approved tanking position such as 'Echelon Left' (Figure 2). Upon receipt of the command, the AV would respond with a *'Wilco',* and upon successfully achieving the position send *'Established in Echelon Left'.* However, if the AV was already in *'Echelon Left',* and the tanker command was erroneously sent, the AV would respond with *'Unable, Action Already Complete'.* It is incumbent that the AVO for each AV monitors all data link messages and voice communications that occur between the other segments and his/her respective AV. At any time, the AVO may override a command sent by the tanker (for safety or other reasons) by sending the correct message.

© NASA, Lori Losey

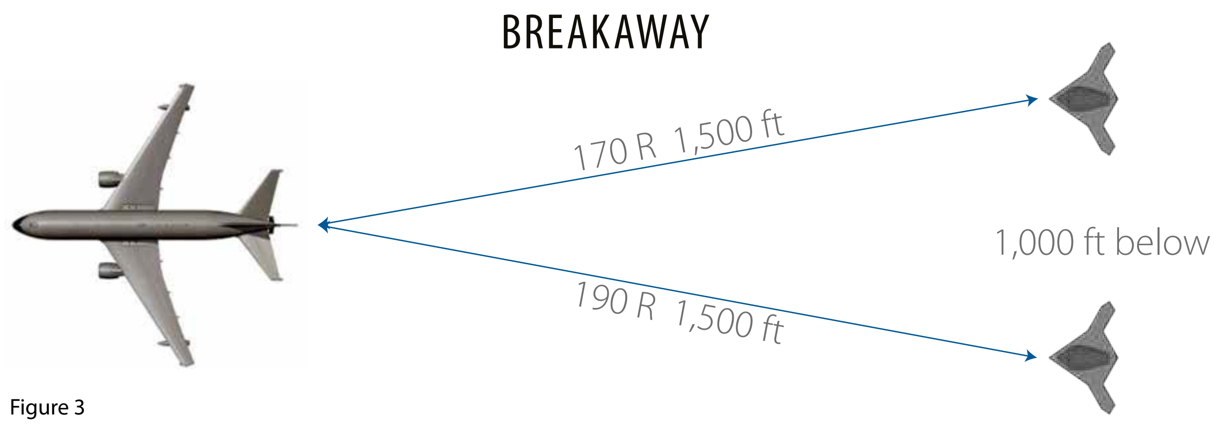


Figure 3

It is also important to note the AV's responses to C2 messaging, both acknowledgements and actions, are automatic and near instantaneous. Therefore, operators need to be exactly aware of the consequences of a command they are about to issue. The ability to exchange these messages in a quick and timely manner demands a strict set of interoperability guidelines for processing requirements (accuracy, latency) and message structure.

Contingencies

An important part of automated systems is the ability to respond to off-nominal scenarios. Whether this is an automated response, or in response to a command, these responses must be clearly defined and integrated into the process ahead of time. The A3R CONOPS document refers to these responses as contingency responses and defines a number of them.

The most familiar to manned operations is the breakaway manoeuvre. Either the tanker or receiver AVO can call for a breakaway, at which point the AV will respond to achieve separation in both altitude and range (Figure 3) to maintain safe flight while the reason for the breakaway is evaluated. Due to the relative navigation and messaging demands of A3R, data link integrity is the key to maintaining safe flight. If at any time the data link is lost, a lost link contingency manoeuvre will be executed where the receiver descends 1,000 ft and turns 30 degrees from the tanker's last known position. In addition, there are other scenarios, some of which are unique to boom receptacle and others are common to both. The common goal in all of these is maintaining safe flight while obtaining safe separation from the other AVs.

Summary

The NATO nations have worked hard to achieve interoperability in our current AAR systems, and the interoperability challenge that A3R presents will be

Steve McLaughlin

received a master's degree in mechanical engineering from Clemson University in 1999 and has since worked as an engineer at the Naval Air Systems Command (NAVAIR). In his time at NAVAIR, he has served as a weapons and stores flight test engineer and as a Senior Engineer for the Fuel Containment and Aerial Refuelling Systems Branch. Steve has supported the design and development of the KC-130J, F-35, Buddystore (F-18) and X-47 air-to-air refuelling systems. He is an active member in the Aerial Refuelling Systems Advisory Group (ARSAG) where he serves as co-chair of the Automated Aerial Refuelling Group. In 2017, NAVAIR recognized him as an Associate Fellow for Fuel Containment and Air-to-Air Refuelling Systems.

Mark Pilling

is a retired Naval Flight Officer with over 3,500 hours in P-3, F/A-18, T-45 and EA6-B aircraft, with an additional 250 hours in Pioneer UAV as both a Mission Commander and Internal Pilot. Upon retirement in 2003, he joined SAIC as a Program Manager and Senior System Analyst. Mark was instrumental in the X-47B demonstration program, assisting in the development, integration, and testing of the carrier-based command and control systems and the tanker based A3R system. Mark continues developing and testing advanced aerial refuelling system concepts with his support of the Navy's Fuel Containment and Unmanned Carrier Aviation program offices.

no less demanding. The procedures introduced in this article are a starting point in the effort to standardize how A3R will be conducted, but much more work needs to be done. A3R is no longer a simple mechanical interface, but an engagement requiring significant data exchanges.

A3R will require the use of precision navigation, sensors, and AAR systems combined with a networked data link. Therefore, a specific set of precision navigation, informational, and system status data will need to be shared between platforms to conduct A3R successfully. At a minimum, requirements for accuracy, integrity, continuity, and availability of the underlying sensors and systems will need to be defined. At the core is the ability to accurately determine a system's precise location in a reference coordinate frame. All data link message format and content will need to be defined in a NATO standard. Additionally, clearing tanker and receiver pairings for A3R will require significantly more data compared to today's systems.

As the US and other nations continue their research and development of Unmanned Aerial Vehicles capable of in-flight refuelling, an operational system is in the near future.

Overall the path to operational A3R will be made easier if we begin standardizing the equipment and airworthiness requirements, as well as the procedures, now. ●

Phillip 'PD' Weber

is a Defence Analyst at Coherent Technical Solutions working on a variety of projects aimed at increasing the effectiveness and lethality of the Carrier Air Wing. A retired career Naval Flight Officer, he served as a Radar Intercept Officer in the F-14A, B and D where he completed three operational tours, a tour as an F-14 instructor, a test squadron tour as the F-14 Project Head and a command tour. He is also graduate of the Royal Air Force Command and Staff College. After retirement PD was an advisor to the Republic of China Air Force at their Operational Test Squadron. Following this he began supporting NAVAIR with the X-47B demonstration and the Unmanned Carrier Aviation program.

Ba Nguyen

graduated from USAF Undergraduate Pilot Training (UPT) under a Vietnamese Military Assistance Program in 1971. He accumulated ~2,500 hours in the A-1, A-37 and F-5 aircraft during Close-Air Support missions, leaving Vietnam on the last day of the war, 29 April 1975. Ba joined the US Air Force Research Lab in 1987, and received a master's degree in aerospace engineering from the University of Dayton in 1991. He has supported the F-16 Variable Stability In-flight Simulator Test Aircraft development, and served as Chief Engineer of Phase I Automatic Air Collision Avoidance System development. As Chief Engineer of AFRL's Automated Aerial Refuelling program he is now AFRL's Subject Matter Expert for related development and a senior engineer for autonomy technology development.

The Challenges of Fifth-Generation Transformation

By Wing Commander André Adamson, UK Royal Air Force
By Colonel Matthew Snyder, US Air Force

This article reflects the authors' own views and not the official policy of their respective organizations. It is an abridged version of a longer essay published in the Royal United Services Institute (RUSI) Journal in August 2017.

Introduction

Plan Jericho, published in 2015, outlined a strategy that would transform the Royal Australian Air Force (RAAF) into a fifth-generation air force by 2025 which, if delivered on schedule, would make it the world's first. The transformation is not based on merely the possession of the next generation of aircraft technology including the F-35A, P-8 Poseidon, EA-18G Growler and E-7A Wedgetail, but on a reconceptualization of the RAAF as an integrated, networked force. Significantly, this new operating concept is based on working in a highly collaborative manner with the army, navy, industry and allies – especially partners in the F-35 programme – in order to achieve the full potential of the new technologies, and to ensure that the networked force is capable of working effectively with them.

The Australian plan has given many air forces pause for thought. That an air force comprising fewer than 15,000 regular personnel is seeking to transition to an entirely fifth-generation air force within the next decade to meet its strategic and security objectives demonstrates an undertaking to conduct future air operations in a conceptually different way. The commitment to a similar transformation among other F-35 partners is firmly underway – both the US Air Force and the UK Royal Air Force (RAF) have pledged to transition to fifth-generation air forces.[1] In contrast, for air forces that are not committed to a fifth-generation programme, or the transformational concepts that underpin it, the time is rapidly approaching where a hard-nosed evaluation and decision will need to be made on where they want to be as an air force in the next 10–15 years. The choice is tactical, strategic and political.

This article analyses some of the stakes involved as the introduction of the F-35 increasingly acts as a driver for fifth-generation transformation. It will also consider some of the implications for air forces that have committed to fifth-generation programmes and, perhaps more significantly, for those that have not.

The Partners and Why They Joined the F-35 Programme

Nine countries originally signed up as partners to the Joint Strike Fighter (JSF) programme, the precursor to the F-35: the US; the UK; Australia; Canada; Italy; The Netherlands; Norway; Turkey; and Denmark. Three others committed through Foreign Military Sales: Israel; Japan; and South Korea. As the most expensive military development and procurement plan in history, the F-35 has attracted a great deal of controversy since the development contract was signed in November 1996. From its conception, the JSF was to be an international co-development programme, a decision that was driven by a number of factors. All of the partners were either NATO countries and/or close US allies, and there was, from the outset, a clear imperative for interoperability and interconnectivity in coalition-based air operations. The partners had been operating a range of different platforms of varying levels of capability, and the F-35 enabled them to operate the same aircraft with all the evident advantages that brings in terms of interoperability, training, and logistics, among others. Furthermore, the partners were all involved, to varying degrees, in the design, building and testing of the aircraft. This was a unique element of the programme that helped maintain domestic hi-tech military industries.

However, the F-35 programme and the cooperative and industrial advantages it confers are, as described above, more than the next-generation platform conceived at the outset of the JSF programme. It represents a commitment by the partner air forces to exploiting a range of new, highly advanced capabilities that constitute a step change in the gathering, processing and sharing of information, particularly in contested environments. Indeed it is the recalibration of strategic and operational thinking that has been driven by the requirement to operate in those increasingly contested environments, and against near-peer adversaries, which has proved so persuasive in winning the argument for the fifth-generation partners. It has required a shift in thinking and a reconceptualization of the conduct of air operations in the Joint and Combined environment through the significantly enhanced surveillance, command and control, and information sharing that fifth-generation capabilities provide. However, most of the air forces acquiring the F-35 have equally begun to realize that having a fifth-generation aircraft does not merely equate to having a fifth-generation capability as defined above. It also compels air forces to integrate and network with land and maritime forces in an unprecedented way – next-generation air forces will require next-generation joint forces.

Implications for F-35 Partners of Integrating Fourth- and Fifth-Generation Fighters

F-35 production is now firmly underway. This puts considerable pressure on those partner countries and Foreign Military Sales customers to prioritize the elements that will allow them to realize the full force-multiplier potential of the aircraft. This includes

The first RAF F-35B Lightning II aircraft on its way to British soil, escorted by two USAF F-35Bs and two RAF Typhoons, in June 2016.

the enhanced data management, connectivity and bandwidth upgrades required to operationalize and fully exploit the capability that fifth-generation aircraft offer for information-centric warfare and cross-platform connectivity.

In this regard, the F-35 has a 'forcing function' for militaries looking to adopt a fifth-generation standard. Naval and ground forces stand to benefit significantly from the network-centric, cross-platform, multiple-shooter concept of operations of which the F-35 will form such a significant element. As Justin Bronk suggests, given the almost unlimited scope of connecting the F-35 to every system in the battlespace, joint force commands will be compelled to invest in the connectivity and bandwidth for the platforms that stand to provide the greatest increase in combat power and flexibility.[2] This will drive the development of fifth-generation joint forces, a concept that has significant potential, particularly in contested environments. It also is a key element in underpinning programmes such as Plan Jericho – the transformation to an integrated networked joint force that has combat power much greater than the sum of its parts.

Whereas the RAAF is looking to upgrade its entire legacy fleet over the next decade, the majority of the F-35 partners, including the US Air Force, will need to run their legacy fleets alongside their fifth-generation platforms for some years beyond that. The RAF and Italian Air Force, for example, possess the highly capable Typhoon, a fourth-generation aircraft with high performance, an active scan radar, Link 16 and a comprehensive air-to-air and air-to-ground weapons suite. As Bronk points out, in such cases investment in the F-35 and Typhoon should not be seen as a binary choice as 'each aircraft offer strengths to complement the other's capabilities. The combination of F-35 and Typhoon can be far more potent than a force composed entirely of either type in many operational scenarios'.[3]

As a US-led, but highly collaborative, programme, development of the F-35 has drawn the partners together. The sharing of technologies, concepts, tactics, training, maintenance, logistics and procedures represent a significant opportunity for fifth-generation air forces. With the F-35 being operated by so many states there are also substantial prospects for tactical, technical and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The F-35 is a fifth-generation aircraft that will provide costumers with a highly capable and flexible weapons and sensor platform for decades to come.

conceptual innovation which will allow the aircraft to be highly 'future-proof' without compromising issues such as sovereignty, national defence industries or strategic autonomy. All these elements contribute to powerful forces drawing the F-35 partners into what might be described as a fifth-generation 'club'. The level of international cooperation is unprecedented, with pilots training together at the F-35 multinational pilot training centre at Luke Air Force Base in Arizona, maintenance facilities being developed in Italy, Turkey, Norway and The Netherlands, and a global logistics supply chain. The result is a deepening of cooperation between the partner air forces, many of whom already possess a strong ability to do so through links forged over the years through NATO and operating in coalitions since the end of the Cold War.

Implications of Integrated Fourth- and Fifth-Generation Air Forces for Countries that are not F-35 Partners

Air forces that have not yet committed, or do not have current plans to transition to fifth-generation systems, will need to consider the operational and strategic implications of such decisions. Four areas should be considered in light of future military operations: the ability to engage near-peer adversaries in a high-intensity environment; the military status and political parity with allied countries; the integration and collaboration capabilities with partner forces; and the potential limitation of the depth and breadth of defence technological innovation.

As previously discussed, fifth-generation systems are not merely about employing stealth attributes, but rather about harnessing the substantial advancements in processing ability and data fusion capabilities inherent in such systems. Effectively, the aim is to create and operate a networked environment where the lines are seamless between sensors, shooters and operators. As a result, air forces that do not possess these capabilities are likely to find themselves increasingly relegated to a supporting rather than a leading role in planning for, and executing, future contingency operations. Countries that are not able to contribute and operate effectively in high-threat environments will potentially find themselves not on an equal footing with their coalition partners, a position that may compromise their role in military and, increasingly, political decision-making. Except Australia, all of the original nine partner countries are NATO members, allowing the smaller air forces of the Alliance – such as Spain and Belgium – to mitigate the limitations of their continued reliance on fourth-generation assets by optimising the capabilities of the F-35 with their legacy platforms in a NATO context. For larger Western countries not in the F-35 programme – such as France and Germany – there will be particular pressure to prioritize the optimization of their existing platforms with the capabilities of the F-35. With the possible exception of the RAAF, all the F-35 partners will be running legacy fleets alongside their new capability for many years to come and will have to adapt, develop and deploy new technologies and concepts to achieve this. Clearly, for air forces not yet committed to a fifth-generation program, the imperative is to adapt to a future where coalition partners have already taken this step. In short, without fifth-generation aircraft, an air force risks being in a supporting role in a coalition air environment and will require a fifth-generation partner to provide mission success against a near-peer adversary.

Finally, the benefits of privileged access to the highest level of military technology enjoyed by the F-35 are substantial. The highly collaborative nature of the programme ensures that technology transfer occurs at an unprecedented scale and provides a wealth of opportunities for hi-tech defence industries across the partner countries. The fact that the F-35 will be operated by so many states will also boost the opportunities for innovation in disciplines such as engineering and avionics, as well as tactics and concepts. For air forces outside of the programme, technological advances can, of course, be pursued at the national level but they will not benefit from the exchange of ideas, concepts and innovation that are generated by this collaborative programme.

Starting in 2018, the RAAF has been replacing its current fleet of ageing F/A-18A/B Hornets with the F-35A JSF.

Conclusion

After a decade and a half of delays, setbacks and bad press, the F-35 programme and the technological advancements linked to it are gathering momentum. The programme is driving the partner states not just to unprecedented levels of military cooperation and convergence, but developing the networked joint forces necessary to operate in an increasingly contested environment. For states that have chosen not to participate in the fifth-generation programme, the challenges will be tactical, strategic and political.

Countries not actively involved in fifth-generation transformation are starting to face a capability gap that will only continue to widen over the next decade. Other means – political, financial or industrial – will be needed to drive the change necessary to mitigate the divergence or offset its effects. Set against these challenges, these air forces might argue that their national security priorities over the next 10–15 years are perfectly well met by remaining outside the F-35 programme and the fifth-generation capabilities of which it is a core element. They might also credibly contend that legacy assets are inherently less vulnerable to disruption of the networks on which fifth-generation platforms rely and that the significant costs associated with the programme could be more efficiently apportioned elsewhere to meet those national priorities.

The arguments presented in this article suggest, however, that the implications of this approach in the longer-term are potentially serious and that there will be, sooner or later, a cost in terms of capability, operational effectiveness, technological superiority and status. ●

1. The RAF has decided to refer to a 'next generation' air force in its recently published Royal Air Force Strategy in order to emphasize the concept of integration and to reduce the risk of the strategy being seen to be platform based. See RAF, 'Royal Air Force Strategy: Delivering a World-Class Air Force', 2017.
2. Justin Bronk, 'Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military', RUSI Whitehall Reports, 1–16 (Feb. 2016), p. viii.
3. Justin Bronk, 'Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military', RUSI Whitehall Reports, 1–16 (Feb. 2016), p. viii.

André Adamson

is a Wing Commander in the RAF and military desk officer for UK-France relations at the UK Ministry of Defence. His previous posting was as an exchange officer in the Strategy Division of the French Air Staff in Paris, prior to which he served in a wide variety of operational and staff posts in the UK and overseas during a 26 year military career. He holds an MA and PhD in War Studies from Kings College London.

Colonel Matthew Snyder

is the USAF exchange officer to the Strategy Division in the French Air Staff in Paris. His previous assignment was as Chief of Nuclear Deterrence Operations at the Pentagon. He has held joint, command, operational, maintenance, and test assignments including combat experience in the B-2. He holds a MSc in Space Systems from the Air Force Institute of Technology and a MA in International Relations from the University of Oklahoma.

A fourth- and a fifth-generation aircraft flying together (F-16 and F-35). However, mixing old capabilities with new is easier said than done.

Developing Solutions for Multinational Interoperability

The European Air Group (EAG)

By Wing Commander Jonathan Heald, EAG

'Coming together is a beginning, staying together is progress, and working together is success.'
Henry Ford

Interoperability – What is the Problem?

Darts and golf are sports played by individuals. Most able-bodied darts or golf players would agree that the process runs more smoothly if they perform the motions on their own, rather than being tied up by someone else trying to help. Military operations are in stark contrast: by their nature, they can only be successful when people work together. Although military personnel may have something to learn from darts players, golfers and others in terms of individual skills, in military operations it is the synergies, force multipliers and cooperation that make the big difference. This principle was realized by the early armies of long ago and remains a fundamental part of military operations today at all command levels. The principle applies just as much when entirely separate military organizations must work together, a business that is commonly referred to as 'interoperability', which NATO defines as *'the ability for Allies to act together coherently, effectively and efficiently to achieve tactical, operational and strategic objectives.'*[1]

This is familiar territory for military organizations, yet when forces from different nations have to cooperate there can be a marked difference between the 'principle' of interoperability and what can be put into practise. In multinational operations, various barriers tend to emerge that inhibit the interaction necessary to enable participants to work properly together.

Examples of these barriers will be recognizable in most organizations: prioritizing national business first, resource limitations, organizational policies, national policies, technical differences, security caveats, language differences and so on. Many organizations are working to overcome these barriers, but turning ambition into results is a tough business. As an example of an allied organization working to produce solutions for interoperability, this article explains the work of the European Air Group (EAG) and its perspective on addressing the challenges for interoperability. In today's rapidly changing and increasingly complex world, interoperability is not a matter that can be sufficiently addressed by focussed, case-by-case agreements. Instead, it will increasingly depend on the ability of allies to act collectively and decisively, when and where required, across a spectrum of activities. In short, there is a compelling need to interoperate.

Pulling the Strings Together

When France and the UK founded the 'Franco-British European Air Group' in 1995, they did so because the air forces of both nations realized that to conduct operations together successfully, they first had to prepare together. They recognized that 'preparation' did not just rely on high level agreements, but also depended on cooperation between organizations at the grass roots level, in terms of knowledge, tactics and procedures. What was needed was a new organization that could bring operators together and produce tangible results, to improve their cohesion.

The Franco-British initiative gained momentum and in 1998 it formed the basis for establishing the EAG, an organization underpinned by an Intergovernmental Agreement between its seven Member Nations: Belgium, France, Germany, Italy, the Netherlands, Spain and the United Kingdom. The EAG's purpose is to 'improve the operational capabilities of the Parties' Air Forces to carry out operations in pursuit of shared interests, primarily through mechanisms which enhance interoperability'.[2]

The EAG is an example of how interoperability between air forces can be significantly improved if they collaborate in training and exercises, share capabilities and develop common tactics, techniques, procedures and doctrine. A key component for success is the ability of the participants to pinpoint the areas in which the greatest value can be added. This task is not as straightforward as it might at first appear: general subject matter may be easy to name, for example: 'cyber', but identifying the specific areas that need to be worked on, agreeing on common visions of the way forward and then transforming these into some form of output that personnel and organizations can put into practise, is another matter.

As an organization, the EAG has been established to address these very issues and engage primarily at tactical and operational levels, placing an emphasis on delivering results that can quickly be put into action. During its existence, it has generated numerous beneficial projects across the air power spectrum, such as enabling better interoperability between fighter aircraft, in air transport operations, logistics, communications, force protection, personnel recovery, aviation medicine and much more.

By identifying gaps, issues and opportunities, and then developing solutions, the EAG today manages more than twenty multinational interoperability projects across four domains, including air operations, force protection, logistics and CIS/Cyber. The outputs range from standard operating procedures to internet-based information platforms, collaborative forums, high-level Technical Arrangements, an advanced training and exercises masterplan, and the long-running exercise series conducted under the umbrella title of

The EAG regularly coordinates multinational VOLCANEX Force Protection doctrine and training exercises, with a strong emphasis on C2.

'VOLCANEX'. This work has also been the catalyst for initiatives that have grown to a substantial scale, such as the European Joint Personnel Recovery Centre at Poggio Renatico Air Base in Italy and the European Air Transport Command based at Eindhoven Airbase in the Netherlands.

Core Business

Every organization must operate within limited resources and the EAG is no exception. Although a vast number of subjects could potentially be engaged, the list of what can be worked on and achieved has to be assembled realistically. However, by combining inputs from the Member air forces and coordinating activities with partner organizations, the opportunities to improve interoperability can be identified, agreed, shared, developed and implemented effectively.

In the EAG's case, its work is enabled by a centrally located Headquarters containing a multinational permanent staff based at Royal Air Force High Wycombe in the UK. It is important to stress that the EAG is a collective organization comprising seven air forces and not just a Headquarters, which works on behalf of its Members. In order to function, the EAG draws on expertise from its Members and from partner organizations, including the Joint Air Power Competence Centre (JAPCC), NATO Allied Air Command, European Defence Agency, Tactical Leadership Programme, United States Air Forces in Europe (USAFE) and others. This 'networked' approach to the EAG's work provides structure for developing interoperability tools, in a way that supports the needs of all stakeholders and exploits synergies, coordinates activities and avoids duplication. Furthermore there is a conscious awareness that the EAG Member Nations are also members of NATO. Therefore, it is of great importance to ensure that EAG work is aligned with NATO standards and practises, and also harmonized with other organizations, where applicable.

Impact of the Fifth-Generation

'Let our advance worrying become our advance thinking and planning.'
Winston Churchill

Today, the exponential advances in technology and its availability are fundamentally impacting the air domain. Typical of these advances is the introduction of 'fifth-generation' systems, which embrace technological leaps forward in terms of stealth, situational awareness, communications and other factors, and also mark a fundamental shift in emphasis from 'air superiority' to 'information superiority'. The arrival of the 'fifth-generation' opens up new ways of operating for military organizations. However, this prospect does not come without its problems. It is no good trying to operate a versatile new air system that has a stunning capacity to handle information, if it cannot communicate, operate or be understood by people and systems that it has to interact with. In order for fifth-generation capabilities to be exploited, they must be recognized and interoperable with existing systems in the technological, procedural and human domains. In the short to medium term, the challenge for many air forces will be how to integrate the bulk of their existing 'fourth-generation' systems, with new fifth-generation technologies – and vice versa.

In 2016, the EAG Steering Group tasked the EAG Permanent Staff to find solutions to these issues. Since then, the EAG has worked together with its Members and partners to develop what is now called the 'Combined Air Interoperability Programme', or 'CAIP'. The CAIP, which was formally launched in July 2017, seeks to resolve the issues that result from integrating fourth- and fifth-generation weapon systems to achieve a higher level of interoperability in future combined air operations.

The CAIP is both a vehicle for identifying future interoperability challenges and a structured approach to resolving them. It envisages a long-term goal for 2030+, but it is driven by a more immediate, intermediate goal for 2022 that defines achievable criteria for fourth-/fifth-generation interoperability. Using the 2022 goal as the immediate target, the challenges that need to be overcome have been identified, objectives established and roadmaps developed in order to address each challenge. Although the EAG has led the development of the CAIP, the work involved will not all be EAG business. Collaboration is underway with NATO Allied Air Command, the JAPCC, USAFE and other organizations to address some challenges identified by the CAIP, where these can be more appropriately handled by other organizations. The CAIP is therefore a focal point for activities that involve multiple organizations, all of which will contribute to achieving the EAG's 2022 intermediate goal for multinational, fourth-/fifth-generation interoperability.

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The Road Ahead

This year the EAG celebrates its Twentieth Anniversary, having first been established in its current form in 1998. Today, the global context in which the EAG and its partners must operate is changing on an unprecedented scale. In an evolving political, social, technological, economic and security environment, new opportunities and challenges are appearing from unexpected angles. New frontiers and potential battlegrounds are also emerging, and once unfamiliar terms such as 'cyber attacks', 'fake news', 'non-state actors' and others have become common language. For every military organization, remaining static will not be a survivable option. To counter the diversity and proliferation of new threats, the development and employment of systems are becoming more complex, and costs are increasing. Therefore, the need for allies to be able to act together – to interoperate – is more vital than ever.

A key challenge for interoperability will be to make sure that principles are put into practise. This, in turn, will depend on the participants committing the time and effort to bring together assets, procedures and, crucially, personnel. These central factors will determine whether or not allies will truly be able to function, not just collectively but also decisively, whenever, however, and wherever this may be required.

The EAG has traditionally adopted a tactical and operation focus, but the effect of such work can be strategic. A central component for interoperability going forward will involve positive and sustained momentum for collaboration from the organizations involved – which means that the sharing of ideas, networking and communication between them will be essential. This requirement poses other questions: just what information can be shared and what cannot? Where does multinational 'interoperability' really sit on the list of priorities? How will we really put this new stuff into practise? While it may not be possible to overcome all of these issues, a coordinated, targeted approach to breaking down barriers at key points can certainly produce results.

For the EAG, the development of the CAIP as part of its core business is an example of a way forward in a specific domain that can benefit both its Member nations and its partners. Using this methodology, it may also be feasible to examine ways of achieving interoperability in other environments, in which synergies can enable allies to stay ahead of the threats. All of this is achievable, but collective success will depend on three factors: the willingness to move forward together, the commitment to do so, and – that most essential of components – trust. ●

1. NATO AAP-06, NATO Glossary of Terms and Definitions. Available at: https://nso.nato.int/nso/terminology_Public.html
2. Original: Agreement Between the Government of the United Kingdom and the Government of the French Republic Concerning the European Air Group, Article 2, dated 6 Jul. 1998; amended by the First Amending Protocol, dated 19 Jun. 1999.

Wing Commander Jonathan Heald

studied physics at university in Canada, before joining the Royal Air Force as a pilot in 1985. He has flown as a helicopter pilot in numerous roles, including air, land and maritime operations, and instructed Royal Air Force and international student pilots on helicopters and fixed-wing aircraft. His staff tours include aviation safety, joint helicopter operations and HQs. He has carried out flying duties in Afghanistan, Hong Kong, Iraq, Kuwait, the USA, throughout Europe and elsewhere. He also has extensive search and rescue experience, from a C2 perspective and as a helicopter squadron commander. He is currently the Executive Officer of the European Air Group, based at Royal Air Force High Wycombe in the United Kingdom.

German Navy Frigate SACHSEN fires an SM-2 surface-to-air missile, which is designed for fleet-area defence against today's advanced anti-ship missiles and aircraft.

Sea-based Ballistic Missile Defence

German Contribution to a Future European Capability

By Rear Admiral (ret.) Jürgen Mannhardt, DEU N

Introduction

Despite many UN resolutions, an ongoing series of North Korean missile tests have recently alarmed the world. Effective media propaganda, provocative performance displays, and the apparently unpredictable government are raising concerns about appropriate preventive measures. This escalation challenges the US in particular because of its role as a protective power in the North Pacific region. Moreover, US territory has come inside the effective range of such long-range ballistic missiles (BM).[1] The geographically distant European nations and their close allies might feel safe in regard to this scenario. However, similar weapons also undoubtedly exist in Europe's southern and south-eastern periphery. In fact, a number of states in the eastern Mediterranean and its adjacent regions meanwhile possess modern BM, whose advanced technology and extended ranges increase the probability of threats from more distant regions.[2] If these weapons get into the wrong hands, the call for precautionary measures would suddenly be omnipresent.

At the 2016 Warsaw Summit, Heads of States and Governments committed to providing armed forces with sufficient and sustained resources for defending NATO territory and populations in a high-intensity conflict. With that in mind, national contributions to Ballistic Missile Defence (BMD) are crucial to support the Alliance's collective defence effort. From a European perspective, this means providing NATO with a self-sufficient European BMD capability. Consequently, provisions with respect to a flexible and effective BMD capability based in Europe, to include an easy to redeploy shipborne solution, are no vague, futuristic project but part of a responsible defence posture.

NATO's BMD Dependence on the US

The development of a NATO 'missile defence system' has been discussed since the early 21st century. At the 2010 Lisbon Summit, it was decided to build up a defence capability for the whole Alliance territory (NATO BMD).[3] Since the 2012 Chicago Summit, NATO has been running the BMD Operation Centre (BMDOC) at Ramstein, with Germany providing infrastructure and expertise. Voluntary contributions from Nations include stationing of sensors or intercept missiles (PATRIOT systems)[4] for the lower layer, i.e. for shorter range BMD engaging targets well inside the Earth's atmosphere.

As part of its 'European Phased Adaptive Approach' (EPAA) programme, the US is still the only provider of land-based and ship-based effectors for defence against long-range BM in the upper layer, i.e. outside the atmosphere.[5] According to current knowledge, this is the most effective way to counter BM. None of the European national armed forces currently possess any comparable capability.

The US Navy thus provides four US Navy AEGIS destroyers[6] stationed in Rota, Spain, and equipped with Raytheon's Standard Missile 3 (SM-3). If necessary, these destroyers could provide a limited BMD umbrella to protect European and Israeli territory from BM attacks, potentially including Weapons of Mass Destruction (WMD). However, the US commitment to Europe may decrease, or capacities could be shifted to the Pacific depending on the situation. The current US administration, therefore, demands Europe, especially the economically strong nations, to contribute more capabilities for the defence of their region. While there is broad consensus among European nations about this requirement, the initiation of concrete measures to achieve the goal is apparently lagging behind, due to limited budgets and the previously perceived willingness of the US to take the precautions necessary for Europe.

German Contribution to Integrated Air Missile Defence

While the German Air Force is well equipped in the lower layer BM intercept level (or lower tier in US terminology), the Bundeswehr cannot contribute directly to the defence against medium- or long-range BM outside the atmosphere. The protection of Germany or an ally against such a threat is foreseeably dependent on the US to provide EPAA resources. However, the German Navy can contribute to the protection of naval units with its SACHSEN class (F124) frigates and Standard Missile 2 (SM-2) effectors to provide advanced air defence (AD), which encompasses short-range missile threats. This was convincingly demonstrated in former 'Cooperative Deployments' with US carrier battle groups including AEGIS ships operating in their BMD role. An upgrade of the F124 class's obsolete SMART-L radar system[7] is furthermore planned on the mid-term to achieve a BMD sensor capability. This will allow Germany to provide a substantial sensor contribution for early warning and target pre-assignment against BM in the upper layer. This BMD spotter capability could be expected in five to six years at the earliest (first modified F124).

However, German defence planning does not foresee the development of a capability to engage BM outside the atmosphere (F124 or successor as shooter), since there has been no specific political guidance. Even if such political will was expressed right now, this capability could not be achieved earlier than in the mid-2020s. Nonetheless, for years, the German Navy has paid considerable attention to the further development of sea-based BMD. In relevant international panels and conferences, Germany has not only supported sensor development but also – at least in the long-term – encouraged building-up a maritime European BMD capability.

At the 2014 Summit in Wales, Germany above all favoured the Framework Nations Concept (FNC) for a capability build-up in areas ('clusters'). The principal idea of the FNC is that individual Nations or single services take up the initiative and bear the main burden – or provide the framework – for the delivery and further development of certain capabilities. Since April 2015, the German Navy has taken leadership of 'Upper Layer BMD', which is a sub-cluster to the overall 'Air & Missile Defence' (AMD) cluster coordinated by the German Air Force. Cooperation partners in 'Upper Layer BMD' are Denmark, Belgium, and the Netherlands.

During the 'At Sea Demo 2015', which was planned and directed by the Maritime Theatre Missile Defence Forum (MTMD-F)[8] and following a German-Dutch operational concept, units from eight nations tested for the first time in European waters a coordinated AD and BMD against targets in the upper layer. The German Navy participated with a number of field grade officers and manned the Chief of Staff position. In May 2017, Germany took over the MTMD-F lead for another sea-based BMD exercise (FORMIDABLE SHIELD) which took place in autumn 2017 in the area of the northern flank, again with corresponding German design and participation.

Suggestions for a European Sea-based Shooter Contribution

With regard to developing an affordable European contribution with maritime BMD shooters, one should discuss different options up to and including the leasing of intercept missiles. In particular, it would be worth considering a European missile pool with reasonable capacity that is also available for the US Navy. European allies such as Belgium, Denmark, Germany, the Netherlands, Norway, and Spain, together with the US, could provide enough sea-based BMD capacity for the Mediterranean, taking the four deployed US Navy AEGIS destroyers into account and presuming the six aforementioned

The US Missile Defence Agency successfully tested the SM-3 Block IIA missile interceptor in February 2017.

European navies would altogether come up with six BMD frigates. Keeping the permanent operational duties of the European navies in mind, the call for this number of ships equipped for the BMD shooter role should be seen as appropriate (one per nation on average, or fewer nations sharing the cost of more than one). With a pool of ten total ships, the US and European forces could maintain a permanent presence of up to four BMD shooters in the Mediterranean area with a common stock of intercept missiles, while respecting a rotation cycle of mission, maintenance, and mission preparation.

Recommendations and Outlook

The Alliance's planning objectives include the build-up of BMD capabilities under the principle of burden sharing. There are a number of NATO activities, concepts, and decisions pursuing this goal and the German Navy has a significant contribution to conceptual and tactical developments in the area of sea-based BMD. Its leading role in the FNC (subcluster Upper Layer BMD) is appreciated among nations and within NATO. With the SMART L ELR radar[9] implemented on the Royal Netherlands Navy's frigates starting in 2018/2019 and the later sensor upgrade on the German F124, there will be for the first time self-reliant European sensor capabilities available for the acquisition of BM targets in the upper intercept layer.

Meanwhile, the current security environment and future trends underline the necessity of maritime BMD shooters. 'Persuasive' efforts are required in this regard to achieve tangible impetus from the political leadership, because without political will the shooter option remains infeasible. In many European countries, to include Germany, public support, and therefore the politicians' appetite for investing in new armament are rather low. Here, one should develop the basic understanding that AD and BMD capabilities – with or without shooter – are defensive by design and, hence, functionally reactive. Developing NATO BMD is therefore not an aggressive action and, in particular, not an offensive threat directed against Russia. However, current NATO-agreed threat estimates indicate that – apart from other perceived threat directions – BMD precautions are also necessary in regard to that military potential. For most of the related questions, one should seek broad consensus at the political and military level not only nationally but also with the allied nations, who are all facing the same challenges.

Because of the expected cost implications, Nations should cooperate from the outset with selected European partners, who already have specially designed anti-air warfare frigates equipped with respective sensor technology and shooter upgrade options (or will introduce these in the foreseeable future). Because of the broad BM threat spectrum and massive cost of

The HNLMS de Ruyter (F-804) is a highly advanced air-defence and command frigate of the Royal Netherlands Navy. The planned modernization of its SMART-L radar to ELR mode will extend the maximum detection range to 480 km (280 nmi).

capability development, BMD in Europe cannot be a purely national endeavour. Also, one should prefer the procurement of already developed and introduced technology fulfilling the requirement. In fact, the SM-3 is an already available intercept missile for the upper layer, which over many years has well proven its functional and operational capability in over 30 test firings at and from the sea. Investment in SM-3 might be the swiftest and most expeditious way to acquire a full BMD capability for the European NATO Nations. ●

1. Ballistic Missiles (BM) or rockets reach their target under the physical law of ballistics. Principally, their trajectory (a launch parable) corresponds to that of a projectile. Contrary to cruise missiles or guided weapons, they do not have a wing structure or cruise engine and are accelerated only in the boost phase. BM can reach both tactical ranges (Theatre Ballistic Missile – TBM) and strategic ranges and are able to carry different kinds of warheads.
2. While BM are generally employed against targets on land, recent technological developments also include the emergence of Anti-ship Ballistic Missiles (e.g.: DONG FENG 21-D). Altogether, an increase of SRBM (short range ballistic missiles with ranges of up to 1,000 Km), MRBM (medium range ballistic missiles/ range 1,000–3,000 Km) and IRBM (intermediate range ballistic missiles/range 3,000–5,500 Km) can be observed.
3. Principally, it is differentiated in (1) Theatre Ballistic Missile Defence (TBMD) as the protection of NATO forces, objects and installations, and (2) NATO BMD as the protection of territory and population of the European NATO partners.
4. The MIM-104 Patriot is a Surface-to-Air Missile (SAM) system manufactured by the US defence contractor Raytheon and derives its name from the AN/MPQ-53 radar component of the weapon system known as the 'Phased array Tracking Radar to Intercept on Target' (PATRIOT).
5. US contribution to the NATO BMD structure in Europe: AEGIS ships, mobile sensor AN-TPY-2, installation of two land-based AEGIS systems in Poland and Romania with SM-3 Block IIa.
6. The AEGIS combat system is designed for air defence as well as BMD, currently presenting the only basis for SM-3 interceptor employment. The US Navy is the main AEGIS user on the Arleigh-Burke- and Ticonderoga-Class. Other users include the Norwegian, Spanish, Japanese, Australian, and South Korean navies. Basically an AEGIS command guidance will be not necessarily the only option to employ the SM-3.
7. Signal Multibeam Radar for Tracking, L band (SMART-L).
8. The MTMD-F is an eleven-nation informal body and think tank formed in 1999 to create international co-operation in the area of Maritime Theater Missile Defence. Although initially set up for maritime BMD, the Forum has evolved to consider cooperation in other mission areas, such as land attack and ship self-defence.
9. As designed, SMART-L has a maximum range of 400 km (220 nmi) against patrol aircraft, and 65 km (35 nmi) against stealthy missiles. A software upgrade, Extended Long Range (ELR) Mode, extends the maximum range to 480 km (260 nmi).

Rear Admiral Juergen Mannhardt (ret.)

has served aboard fast patrol boats, destroyers, and frigates in various positions up to deputy and Chief of Staff DEU Flotilla 1. During his last assignment at sea, he was Commander Maritime Task Force 448 UNIFIL and served two times under US Central Command in Tampa and Bahrain, earning various awards like the OEF- and the UNIFIL-medal. Holding a Master's Degree in economics, he took part in the 29th Admiral Staff Course and was a lecturer for Leadership & Management and Operational Art at the Bundeswehr Command and General Staff College in Hamburg. Before he retired at the end of 2016, his last flag officer assignments were Superintendent of the German Naval Academy in Flensburg, Deputy Commander of the Naval Office and Head of Plans and Policy Directorate of German Navy Headquarters in Rostock. Today he consults for a number of German and international companies on defence matters.

The Role of BMD in Deterrence?

By Lieutenant Colonel Andreas Schmidt, DEU AF, JAPCC

Introduction

Neither Ballistic Missile Defence (BMD) nor deterrence are new topics, and for a good part of the last half-century, the contribution of BMD to deterrence (during the Cold War) was limited but well understood. The western position that it is easier to build a bigger nuclear arsenal to ensure second strike capabilities, rather than trying to defend strategic stockpiles with BMD systems, gave BMD less relevance in deterrence policies. However, numerous variables have changed over the last three decades, which leads to a new understanding about the potential uses for deterrence purposes. The following article will try to identify some of the more important applications and will show that despite the defensive nature of BMD, it can have negative effects on deterrence, as well.

What is Deterrence?

According to the Oxford Online Dictionary, deterrence is defined as: *'The action of discouraging an action or event through instilling doubt or fear of the consequences.'*[1] This is similar to the NATO Terminology

A Patriot launching station of the US 2nd Air Defense Artillery Regiment at Gaziantep (Turkey), in February 2013.

Database definition: *'The convincing of a potential aggressor that the consequences of coercion or armed conflict would outweigh the potential gains.'*[2] These definitions are very general, and rightfully so. There is no universal formula on how to deter a potential adversary but, by practical definition, it can be assumed that deterrence has failed when missiles fly.

The following two statements by Glenn Snyder *'Deterrence works on the enemy's intentions, while defence reduces its capabilities',* and *'Deterrence is by definition a peacetime objective, while defence is a wartime value'* seem to support this.[3] However, how BMD, as a defensive capability, can contribute in times of deterrence still needs to be analysed. Normally, the need for deterrence is perceived if a nation's vital interests are threatened. To deter successfully, it is important to have the right capabilities, sufficient capacity and credibility, and the means to communicate intent. However, it is key to recognize and identify threats correctly; otherwise, an action intended as a stabilizing deterrent might be perceived as an unfounded threat itself, which could have an escalating effect. This has been termed *'the security dilemma'* by academia.[4] Also, it is vital to understand the adversary's value system and definitions of success/victory to compose a functioning set of deterring measures.[5]

An adversary can be deterred by threatening his ambitions and value systems or by increasing the cost and risk of pursuing his goals. A credible threat requires the combination of capability and intent, and the capability must be able to deliver a credible combination of risk and cost.

Overall, there are numerous forms of deterrence. From a chronological perspective there are *'general deterrence'* and *'immediate deterrence',* and from a political and military effects perspective, there are *'deterrence by punishment'* and *'deterrence by denial'.*[6] Comprehensively there are also other, non-military measures to deter potential adversaries, such as economic sanctions, strategic treaties, or humanitarian aid, but these are not the focus of this article.

If deterrence measures are being employed but are not challenged by a potential adversary, it is called general deterrence. When the general deterrent is being challenged, but the challenger is dissuaded

from using force, it is called immediate deterrence.[7] Since in both phases ballistic missiles can be used to threaten friendly interests, BMD can also be used as a deterrent in both. Deterrence by punishment, like the Cold War concept of Mutually Assured Destruction (MAD)[8], deters by threatening to impose unacceptable costs on the adversary, outweighing his potential benefits of his contemplated action(s). Deterrence by denial, in comparison, is denying the opponent his war aims[9].

Because BMD is a purely defensive weapon, it is part of the deterrence by denial portfolio, but can increase cost and risk for the opponent, which will be shown below. The advancements of BMD technology since the end of World War II are remarkable, from the first conceptual US studies of possibilities of intercepting ballistic missiles such as the German V2 in the 'Wizard Program'[10], through the idea of intercepting incoming missiles with nuclear warheads (e.g. Nike Zeus), to modern-day hit-to-kill technology, which uses kinetic energy to destroy warheads in the exo-atmospheric midcourse phase of a ballistic missile's flight path. The achieved technical feasibility, combined with the significantly increased probability of successfully intercepting ballistic missiles, opens up new ways of employing current BMD means.

To understand how BMD can contribute to deterrence, we need to understand why ballistic missiles threats are so special. There are numerous classes of ballistic missiles, initially categorized by their range from Short Range Ballistic Missile (SRBM; up to 100 km) to Intercontinental Ballistic Missile (ICBM; greater than 5,500 km). Furthermore, they can vary in number and type of warheads (e.g. regular re-entry vehicles, manoeuvring re-entry vehicles, or hypersonic glide vehicles), different payloads (e.g. conventional, biological, chemical or nuclear), propellant (liquid or solid), launch platform (e.g. fixed site, mobile launcher, submarine or even air-launched), or potential BMD countermeasures (e.g. manoeuvrability or decoys). Ballistic missiles are attractive to a lot of state and non-state actors because their range, speed and high trajectories give them a unique reach, and make them much more challenging for defences to intercept than do other delivery systems, such as manned aircraft or cruise missiles.[11] In asymmetric conflicts with non-peer opponents, they can be used as a tool for coercion, due to elevated chances of successful effect delivery.

Benefits of BMD to Deterrence[12]

As stated above, deterrence works on adversary intentions. Hence, deterrent intent must be communicated carefully and correctly to have the intended effect. Since BMD is generally used in a defensive context, it provides a non-escalating means within the pool of deterring capabilities. By employing BMD, the likelihood of hostile ballistic missiles achieving the adversary's desired effect is reduced. This not only potentially saves many lives but may also deter the adversary from using ballistic missiles at all, since the intended effect becomes unreliable. The adversary's increased uncertainty of reaching their political or military goals with ballistic missiles also reduces the credibility of this threat.

Therefore, ballistic missiles, as a tool of political coercion, might not be used against nations with adequate BMD in the first place. This helps in managing escalation (intended or unintended) of a potential crisis, buys time for diplomacy, and consequently decreases the pressure to take pre-emptive, preventive or anticipatory self-defence actions. Also, since ballistic missiles may have less effectiveness in a BMD environment, the adversary has to decide to either procure a significantly larger stockpile of ballistic missiles (which increases cost) or to reduce his stock and employ fewer missiles in favour of other means. As such, BMD raises the cost of the adversary's offensive capability, which has a deterrent effect of its own.

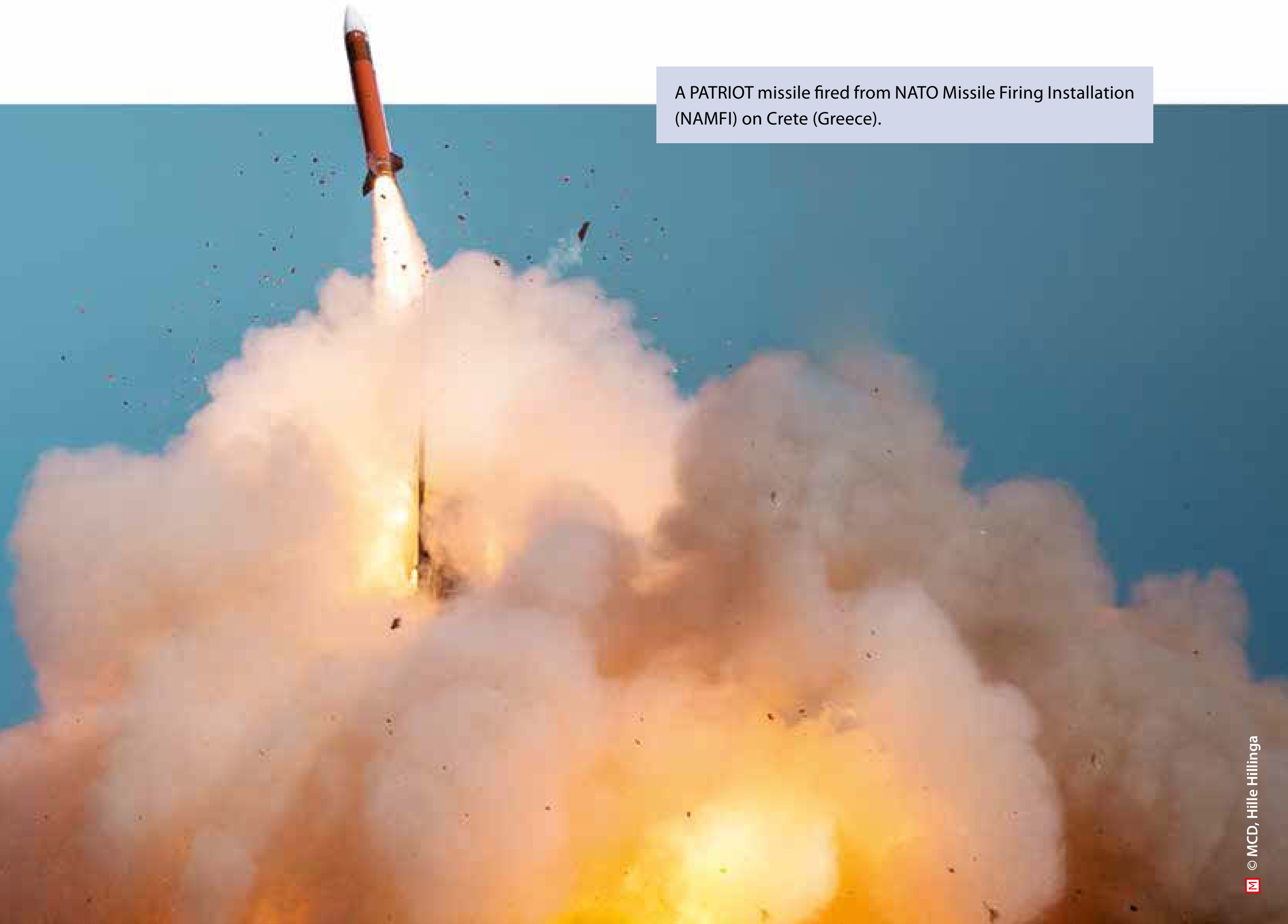
In general, the credibility of a military capability significantly rises when it is successfully demonstrated. Therefore, public ballistic missile tests are often used by an adversary to emphasize the relevance of a nation's capabilities and to increase public pressure on a political level. BMD can be used to mitigate this effect as well.

When switching from general deterrence to immediate or extended immediate deterrence (cooperative sharing of deterrent capabilities to a third party), and once forces start to deploy, BMD has several supporting effects. BMD has proven to contribute to warfighting success by allowing a higher level of freedom of movement and through protection of the deployed forces. This could complicate planning for the adversary, increase his resource demands, and might cause higher attrition rates. Depending on the level of risk aversion or tolerance of the opponent, this may delay or suppress escalation and therefore create a deterrent effect.

The lack of pinpoint accuracy in most ballistic missiles often stimulates the use of Weapons of Mass Destruction (WMD) to ensure a compelling effect is achievable. In other words, employing WMD ensures that near misses can still affect the target, an important consideration, especially for non-peer adversaries. However, effective BMD systems reduce the likelihood of even near misses, thereby reducing the credibility of the threat. This might deter nations from pursuing costly delivery systems and weapons, including WMD. If WMD capabilities are already available to a state, effective BMD raises the threshold of using them, especially in limited attacks, due to decreased odds of success and could cause the opponent to deescalate due to increased risk. In short, the better the defences against ballistic missiles, the less credible the adversary's threats become, and the more risk-accepting and potentially aggressive the BMD owning nation may appear. This perception may serve as a deterrent but might also have unforeseen negative effects.

Drawbacks of BMD[13]

Although technological advancements have made BMD systems very reliable, they cannot guarantee a 100 % intercept rate. Based on technical limitations, the number of available BMD assets and/or sheer numbers of incoming threat missiles, current BMD



A PATRIOT missile fired from NATO Missile Firing Installation (NAMFI) on Crete (Greece).

AEGIS Ashore Missile Defence System in Deveselu, Romania.

systems are not able to create a perfect defence. The possibility of hostile missiles carrying WMD and leaking through defences raises the question of whether the remaining risk of a successful ballistic missile attack, and the extreme consequences thereof, render the high cost of the defence system unacceptable. This also creates political questions about the utility of BMD and undermines its deterrent effect. One can say that the deterrence by denial effect of BMD could trigger, rather than deter, a conflict. This was predicted during the Cold War and led to the Anti-Ballistic Missile Treaty[14] of 1972 between the USA and the Soviet Union.

Also, the better our BMD systems get, the more likely it is that potential adversaries will develop new and better countermeasures which will exploit BMD limitations. Ballistic missiles with multiple warheads, high altitude electromagnetic pulse warheads, faster re-entry vehicles or manoeuvrable ones with less predictable flight paths that reduce intercept probabilities all enhance the chance of successfully delivering the threatened effect. A good example is the UK's Polaris upgrade in the 1960s which was used to counter the BMD shield around Moscow.

If the opponent relies heavily on ballistic missile effects but perceives friendly BMD effective, chances are increased that he will pursue the development or procurement of nuclear weapons to maintain a credible threat. In other words, BMD could contribute to increased WMD proliferation, especially for non-peer competitors. Furthermore, an adversary's proliferation of ballistic missiles or ballistic missile technology to other state and non-state actors might be intentionally increased to ensure an overall advantage against a common opponent.

Successful BMD unbalances the playing field, giving the owner the ability to engage in conflict without fear of BM retaliation. This could be perceived as setting the stage for impending aggressive action, and in the case of a peer or near peer competitor, could lead to a preventive, pre-emptive or anticipatory self-defence first strike, possibly emphasizing asymmetric means that circumvent the BMD capability and maintain a credible threat. Also, this perceived 'aggressive posture' might be misperceived by other potential adversaries, causing an unrelated situation to escalate as well.

In the case of extended deterrence, such as the US employs with partners in the Asia-Pacific region against North Korea, a strong domestic BMD posture might make the primary defender more risk tolerant than the third party itself. This could be a stressor within coalitions on agreeing on the right deterrent when risk perception is inhomogeneous.

Conclusion

BMD has great potential as a contributor to deterrence strategy. It can communicate a defensive posture, increase the time for diplomacy, deny adversaries benefits and impose costs the opponent is unwilling or unable to accept. By limiting the threat through reduction of risk, stimulating adversary restraint in pursuing WMD, and increasing the time for diplomatic solutions, BMD can be a very valuable political tool.

However, since an opponent will seek to maintain his potential level of threat, be it as means of coercion or maybe as a deterrent itself, there can be negative consequences for employing BMD. Therefore, BMD has to be used wisely, and the intent for use needs to be communicated carefully. Also, BMD has to be part of an overall deterrence strategy to de-escalate possible crises. Unless we can employ a perfect and unlimited defence, deterrence cannot be based solely on defensive capabilities. However, even limited defensive capabilities can enhance the deterrent effect of strong offensive capabilities by shifting the balance between opponents. Effective deterrence must present a viable threat through a comprehensive approach which includes offensive military capabilities, to ensure effective levels of cost and risk to the opponent.

Considering present BMD capabilities and the remaining risks and costs of WMD-armed ballistic missile attacks by peer states, BMD is currently not a convincing threat to the deterrence paradigm of MAD. Lastly, BMD systems are very costly (even in small numbers), and they need to be kept up-to-date. Otherwise, they will lose their deterring potential. This can potentially be very costly in the long run and needs to be considered when basing parts of the deterrence strategy on BMD capabilities.

Overall, a robust BMD posture against limited, miscalculated or accidental attacks supports general deterrence; and when coupled with enough additional BMD means to secure vital assets and deployed forces during crises, promises to be an excellent medium to deliver effective political and military deterrent effects in our current security environment.

1. Online at https://en.oxforddictionaries.com/definition/deterrence, [accessed 27 Mar. 2018].
2. Online at https://nso.nato.int/natoterm/Web.mvc, [accessed 27 Mar. 2018].
3. Glenn H. Snyder. 'Deterrence and Defense – Toward a Theory of National Security'. Princeton Legacy Library, 1961. Edition 2016.
4. Online at https://www.britannica.com/topic/security-dilemma [accessed 27 Mar. 2018].
5. Brad Roberts. 'On the Strategic Value of Ballistic Missile Defense'. Jun. 2014.
6. Vesna Danilovic. 'When the Stakes Are High: Deterrence and Conflict Among Major Powers'. Ann Arbor, University of Michigan Press, 2004.
7. Ibid.
8. Henry D. Sokolski. 'Getting MAD: Nuclear Mutual Assured Destruction, its Origins and Practice'. Nov. 2004.
9. Online at https://www.nato.int/docu/review/2015/Also-in-2015/deterrence-russia-military/EN/index.htm, [accessed 27 Mar. 2018].
10. Ernest J. Yanarella. 'The Missile Defense Controversy'. 2002.
11. Jeremy Stocker. 'The Strategy of Missile Defence'. Jun. 2011.
12. Jonathan Trexel. 'Deterring the Democratic People's Republik of Korea: The Role of Japan's Ballistic Missile Defense'. May 2013.
13. Ibid.
14. Treaty Between The United States of America and The Union of Soviet Socialist Republics on The Limitation of Anti-Ballistic Missile Systems (ABM Treaty). Online at https://www.state.gov/t/avc/trty/101888.htm#text [accessed 27 Mar. 2018].

Lieutenant Colonel Andreas Schmidt

joined the German Air Force in 1993. After attending Officers School, he studied Computer Science at the German Armed Forces University in Munich. Since 1998 he built up an extensive background in Ground Based Air Defence, particularly the PATRIOT weapon system. He started as a Tactical Control Officer and subsequently held positions as Reconnaissance Officer, Battery Executive Officer and Battery Commander in various PATRIOT units. Furthermore, he had two non-consecutive assignments in Fort Bliss, Texas. The main task of his first assignment was to conduct bilateral US-DEU studies of weapon system behaviour on a tactical level for the German PATRIOT Office. During his second assignment, he was the Subject Matter Expert (SME) on Integrated Air and Missile Defence at the German Luftwaffe Air Defence Centre. In between, he had an assignment as the A3C in the former Air Force Division. Currently, he is the Ballistic Missile Defence SME in the JAPCC.

Countering Hybrid Threats with Air Power?

Making True Sense of the 'Hybrid Warfare' Concept

By Lieutenant Colonel Martin Menzel, DEU A, JAPCC

Introduction

Events of 2014 forced NATO member states to reconsider the international security environment. In the East, Russia's annexation of Crimea took the world by surprise. Russia's swift victory appeared especially impressive because it stood in stark contrast to the failures of its past military interventions, and it challenged the Western perception that its military was outdated and stuck in a Cold War mentality. Russia's approach, which relied principally on armed yet non-military forces and techniques such as the use of information and disinformation, was particularly alarming.[1]

In the South, NATO faced a new era of protracted instability stretching from the Middle East via North Africa to the Sahel region. The most prominent threat emerging was the Daesh, who became a formidable opponent among non-state, armed groups through their successes in gaining and holding territory, employing a mix of terror and conventional tactics, and attracting thousands of fighters from all corners of the globe.[2]

The earlier dismissed 'Hybrid Warfare' concept seemed to explain these two successes best. Both protagonists had something common in their tactics: the ability to

'Hybrid is the dark reflection of our comprehensive approach. We use a combination of military and non-military means to stabilize countries. Others use it to destabilize them.'[3]

NATO Secretary General Jens Stoltenberg, May 2015

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'The Hybrid Warfare concept and its related terms must be used carefully and precisely when trying to deduce specific military capability requirements from it.'

use a 'hybrid' mix of activities, whose ambiguity makes it difficult to detect, identify, interpret, and attribute a threat accurately. This mix made it difficult to achieve the legal requirement of maximum certainty and determine appropriate countermeasures.[4] From a Western perspective, such threats target our political, economic, and societal vulnerabilities, but remain concealed and below the threshold required for a conventional, collective response under the provisions of the North-Atlantic Treaty.[5]

'Hybrid Warfare' quickly re-emerged as a buzzword in politico-military circles as the Alliance realized the strategic implications of the current developments. However, since then the concept has not only been heavily debated but also often misunderstood and misused. As this article intends to show, the 'Hybrid Warfare' concept and its related terms must be used carefully and precisely when trying to deduce specific military capability requirements – particularly air power requirements – from it.

Prior to 2014 – Rise and Fall of 'Countering Hybrid Threats' in NATO

The popularization of the term 'Hybrid Warfare' can be attributed to the American military theorist Frank

Hoffman, who in 2006, conceptualized an evolution of the battlefield environment that transcends the commonly accepted linear division between regular and irregular types of warfare.[6] Within the Alliance, concerns about 'Hybrid Threats' were first reflected in the NATO Strategic Concept review of 2010 and incorporated in the Bilateral Strategic Command (Bi-SC) Capstone Concept for 'Military Contribution to Countering Hybrid Threats (MCCHT)'. This document was developed based on operational experience in Bosnia, Kosovo, Afghanistan, Iraq, and other countries. Here, adversaries were able to *'conduct hostile actions through a broad array of conventional and non-conventional means and methods, and achieve a favourable outcome against a force that was superior, both technologically and militarily.'*[7] While 'Hybrid Threat' became an umbrella term encompassing a wide variety of adverse circumstances and actions that may occur randomly and be driven by coincidental factors, the possibility of NATO facing the adaptive and systematic use of such means by adversaries in pursuit of long-term political objectives was seen to merit a *'fresh and more conceptual approach from NATO.'*[8]

One of the major conclusions of the Bi-SC Capstone Concept was that an effective response to such orchestrated 'Hybrid Threat' is unlikely to depend on new military hardware but factors outside the NATO military sphere.[9] Countering Hybrid Threats (CHT) would require cooperation with non-military actors and a thorough understanding of civil-military interfaces to achieve unity of effort. This 'Comprehensive Approach', however, remained relatively undeveloped, since the necessary tools for governance and institution building, the rule of law and economic development, and other comprehensive activities, are usually not within the sphere of influence of NATO military staff and national military organizations.[10] Therefore, despite the initial enthusiasm and the productive debate, there was an absence of political will among Alliance members to invest resources in developing the necessary capabilities. In 2012, NATO decided to halt its program of work on CHT, while acknowledging *'hybrid threats will remain an important part of the dynamic and complex security environment and threat lexicon.'*[11]

2014 and Beyond – Scholarly Opinions on 'Russian Hybrid Warfare'

In the wake of Russia's actions in the 2014 Ukraine Crises, a large volume of work has been published on Russian hybrid warfare.[12] However, the general conclusion of strategists, civilian professors, military historians, and practitioners is that a hybrid approach to operations is not new. Many authors are sceptical of the concept, asserting indirect approaches and unconventional tactics, such as the use of proxy fighters, information warfare, psychological operations, or sabotage, have been part of most countries' military toolbox for many years.[13]

Several experts question the relevance of the concept in the Russian case. Bettina Renz states the effectiveness of Russia's operation in Crimea was not the result of applying a new war-winning formula. Instead, the seemingly effortless achievement of objectives in Crimea was the result of extremely favourable circumstances that are unlikely to work in a different scenario.[14] Michael Kofman and Matthew Rojanski, offer a similar opinion saying the chances Russia could repeat a Crimea or Donbas scenario elsewhere are low. Russia's intervention in Ukraine should instead be understood in terms of safeguarding vital national interests by applying the usual national instruments of power (diplomacy, information, military, economy) – a concept that should be well-known to the West.[15]

Other authors highlight the rapid politicization of the term 'Hybrid Warfare'. Kofman and Rojanski reasoned the term has become a *'catchall phrase'* and is *'a poor descriptor having already led Western analysts and policymakers down an unhelpful path.'*[16] In a 2017 publication, Ofer Fridman argues *'from a military tactical-operational concept intended to describe the evolving reality of the battlefield in the 21st century, the idea of "Russian Hybrid War" has been become a panacea to the identity crisis that the West has experienced since the end of the Cold War […] as it allows bringing any hostile action under the same conceptual umbrella, creating a continuity of a unified political message and allowing different internal political players to close the ranks against an external threat.'*[17]

'To respond appropriately to a hybrid threat, we must be able to promptly recognize and attribute hybrid actions and anticipate unconventional activity, as well as the conventional actions. Anticipation requires cooperation at all levels, across multiple ministries and throughout various lines of efforts, pursuing a comprehensive approach across the diplomatic/political, information, military, economic, financial, intelligence, and legal spectrum (DIMEFIL). National, bi-lateral, and collective Alliance efforts must be integrated and mutually reinforcing. We must develop resilience and readiness to resist hybrid actions and we must count on a quick decision-making process to enable our own actions. This is fundamental to our success.'[18]

General Philip M. Breedlove

Further critique is expressed about the misuse of the term 'war' when describing something that does not involve armed confrontation. Renz argues that discussing the centrality of non-military instruments, and in particular information, under the label of 'hybrid warfare' could be a misleading oversimplification.[19] Fridman also says this could be very confusing since *'conceptualizations of non-military confrontations as wars perplex the military leadership, simply because most of the required actions and counter-actions do not fall under military responsibility.'*[20]

NATO's New Strategic Approach to 'Countering Hybrid Threats'

Despite these critical opinions, the 2014 developments quickly drove NATO to put CHT back on its main political and military agenda. Both the NATO Defence College and Allied Command Transformation organized several conferences and workshops, and the NATO Defence and Security Committee, as well as the Military Committee (MC), resumed their work on the subject.

At the 2014 Wales Summit, NATO members agreed on the Readiness Action Plan (RAP) to ensure the Alliance will be ready to respond to perceived new security challenges. In December 2015, the Ministers of Foreign Affairs adopted a strategy on Hybrid Warfare, supplemented by the NATO Hybrid Warfare playbook, laying out who does what in dealing with complex security threat scenarios. While pursuing the readiness required for CHT as part of NATO's collective defence and adopting the willingness to assist an ally at any stage of a hybrid campaign, the Alliance clearly assigned the primary responsibility for responding to 'Hybrid Threats' to the targeted nation.[21]

Recognizing the need for dialogue and coordination with like-minded partners, NATO and the EU are continuing to develop a 'Comprehensive Approach' that fuses all relevant actors and available instruments. CHT is about gaining an understanding of hybrid threats and the innovative use of existing capabilities, many of which reside in non-military governmental and intergovernmental agencies, the private sector, and international non-governmental organizations. In this sense, the NATO-EU joint declaration adopted during the Warsaw Summit in July 2016 outlines the new areas for related practical cooperation in particular through building resilience, situational awareness, and strategic communications.[22]

Hybrid Strategy. A strategy based on a broad, complex, adaptive and often highly integrated combination of conventional and/or unconventional means; with military, paramilitary and/or civilian actors; and both overt and covert activities conducted across the full spectrum of elements of power to target decision-making and complicating engagement.

Hybrid Threat. A state or non-state actor that employs a Hybrid Strategy. (It is assessed that in order to employ a Hybrid Strategy a non-state actor would need the ability to exercise many or all the elements of power normally associated with a sovereign state).

Hybrid Warfare. Adversary employment of a Hybrid Strategy, which includes the threat or use of force. (Force can be used at a lower level than the term warfare may imply to pressure, influence and/or destabilize without necessarily involving the seizure of territory).

Hybrid Model. A specific manifestation of Hybrid Strategy as employed by a particular adversary. (Each Hybrid Strategy will be unique and therefore any response must be tailored to it.)

Figure 1: Terminology Considered by the Military Committee.

The Necessity of Clear and Concise Terminology

To minimize ambiguity caused by non-standardized terminology, NATO has worked since 2014 to develop clear vocabulary regarding hybrid conflict. While there is still no unanimously agreed-upon definition of 'Hybrid Warfare', the MC considered using the terminology shown in Figure 1.[23] If properly used, these terms should provide consistency and help prevent misunderstanding. The essential word is indeed 'hybrid', where a state or non-state actor (the 'hybrid threat') fuses different multi-modal means and methods (employs a 'hybrid strategy') in a way that is tailor-made to the context at hand.

In the author's opinion, NATO as well as EU officials and bodies largely succeeded in the consistent use of the proposed terminology in their subsequent protocols, memoranda, and declarations related to the subject. However, other NATO documents including pieces of work within the air and space power realm have not been so consistent. For example, the term 'hybrid air threat' was introduced in some publications to describe the potential use of unmanned aerial platforms especially if they are small in size and low and slow flying (LSS), and possibly networked through swarming technologies. In these cases, the label 'hybrid air threat' seems to be chosen simply because

1. an adversary actor employs the most modern means available (probably as commercial-off-the-shelf), or
2. the use of this particular technology leads to possible ambiguity in identification and attribution as well as presenting an asymmetric threat difficult do defeat with traditional military air defence assets.

However, none of those characteristics conforms to the 'hybrid' definitions as proposed by the MC and adopted in the Alliance, as no singular, isolated attack with conventional or non-conventional military means alone could be 'hybrid'. Recognizing the overall aspect of 'hybridity' means there is no distinct 'hybrid' type of attack, but it will always be a comprehensive mix of threats requiring a comprehensive response.

As Christopher O. Bowers wrote, *'It is only natural that every armed force will use any and every means available to it. […] One needs to be cautious in simply defining a hybrid adversary as any that engages in multiple forms of warfare, because this can include just about every type of organization. […] If everybody is hybrid, then nobody is.'*[24]

Conclusion

'Hybrid Warfare' is not new. But the way it can be applied in the modern era has in fact changed. Globalization and the increased complexity of the geostrategic environment, enabled by advances in technology and the access to it, have allowed adversaries to blend sophisticated forms of asymmetry to conceal their role as a party to the conflict, with the aim of complicating and delaying decision making. 'Hybrid Warfare' rarely conforms to established laws of war, and its ambiguity poses challenges to our traditional legal and conceptual understanding of crises and warfare. CHT, therefore, requires a higher level of Alliance attention and cooperation through increased strategic awareness (shared intelligence), political will and preparedness (including decision making), strategic communications (countering propaganda), and defensible and resilient networks and economies (cyber defence, economic and societal solidarity).

There is no doubt that in modern warfare the adversary may employ innovative unmanned air threats (such as LSS) whose detection, identification and engagement with air defence and air policing involve new technical and procedural capabilities as well as legal provisions probably not yet available to Alliance members. It is, however, modern technology and employment modes, not 'hybridity', which defines the novelty in this formidable military threat.

Improving NATO's defence and deterrence posture towards emerging security challenges must start with accurately expressing existing capability gaps to the relevant decision makers. Using 'Hybrid Warfare' parlance and related buzzwords to portray a sense of urgency may be ineffective, or even counterproductive. This may particularly be true when it comes to air power, which has a different set of modern challenges and may have limited ability to counter any hybrid lines of attack. Military professionals and specialists should refrain from the inappropriate use of the term 'hybrid' as a prefix, since the all-inclusiveness of the 'Hybrid Warfare' theory may rather confuse and blur the debates the decision makers need to understand regarding the airpower problem in question. The 'hybrid strategist' on the opponent side, though, might consider a lack of such understanding a success. ●

1. Bettina Renz. 'Russia and Hybrid Warfare'. In Contemporary Politics, 22; 3, 283–300. 25 Jun., 2016. DOI: 10.1080/13569775.2016.1201316.
2. NATO Parliamentary Assembly, Defence and Security Committee. 'Hybrid Warfare: NATO's New Strategic Challenge?'. 166 DSC 15 E bis. 10 October, 2015. Par. 8–9.
3. Online at: https://www.nato.int/cps/on/natohq/opinions_118435.htm
4. European Parliament. 'Countering hybrid threats: EU-NATO cooperation'. Mar. 2017. Online at http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599315/EPRS_BRI(2017)599315_EN.pdf
5. Ibid. 2, Par. 19.
6. Dr. Ofer Fridman. 'The Danger of "Russian Hybrid Warfare"'. In Cicero Foundation Great Debate Paper No.17, 5 Jul. 2017. Online at: http://www.act.nato.int/images/stories/events/2010/20100826_bi-sc_cht.pdf, http://www.cicerofoundation.org/lectures/Ofer_Fridman_The_Danger_of_Russian_Hybrid_Warfare.pdf
7. NATO. 'Bi-SC Input to a New Capstone Concept for the Military Contribution to Countering Hybrid Threats'. 25 Aug., 2010. Par. 9. Online at: http://www.act.nato.int/images/stories/events/2010/20100826_bi-sc_cht.pdf
8. NATO Allied Command Operations. 'NATO Countering the Hybrid Threat'. Online at: http://www.act.nato.int/nato-countering-the-hybrid-threat
9. Ibid. 6. Par. 38.
10. Ibid. 7.
11. North Atlantic Military Committee. 'Countering Hybrid Threats – Military Committee Advice (MCM-0074-2012)'. 12 Jul., 2012. The information herewith extracted is considered non-sensitive.
12. Visit the NATO Multimedia Library at: http://www.natolibguides.info/hybridwarfare#s-lg-box-14426065
13. Guillaume Lasconjarias and Jeffrey A. Larsen. 'Introduction: A new Way of Warfare'. In NATO Defence College Forum Paper 24 'NATO's Response to Hybrid Threat', p. 1–2. Rome, 2015.
14. Ibid. 1.
15. Michael Kofman and Matthew Rojansky. 'A Closer Look at Russia's "Hybrid War"'. In Kennan Cable No. 7. Apr. 2015. Online at: https://www.files.ethz.ch/isn/190090/5-KENNAN%20CABLE-ROJANSKY%20KOFMAN.pdf
16. Ibid.
17. Ibid. 5.
18. Foreword in 'NATO Response to Hybrid Threats', NDC Forum Papers 2015.
19. Ibid. 1.
20. Ibid. 5.
21. Ibid 3., p. 4.
22. Ibid 3., p. 6.
23. North Atlantic Military Committee. 'NATO Military Authorities' Advice on the Hybrid Warfare Complementary Assessment – Follow-on Tasking from the Wales Summit (MCM-0022-2015)'. 27 Mar., 2015. The information herewith extracted is considered non-sensitive.
24. Christopher O. Bowers. 'Identifying Emerging Hybrid Adversaries'. In Parameters, Spring 2012, p. 40.

Lieutenant Colonel MBA Martin Menzel

began his military carrier in 1985, spending several years in the German Army Engineer branch including positions as Company Commander, and as Chief Instructor at the German Army NCO School. In 1999, he stepped over into the Military Intelligence branch. With a broad range of intelligence positions and functions held at Headquarters 1st German/Netherlands Corps, Joint Force Command Brunssum. SFOR, and ISAF, he became a highly experienced staff officer with regard to the conduct of military intelligence at the operational level in NATO or multinational staff environments. Since May 2014, Lieutenant Colonel Menzel has been the JAPCC's Subject Matter Expert for Research, Analysis and Intelligence Support as well as serving as Assistant Editor of this journal.

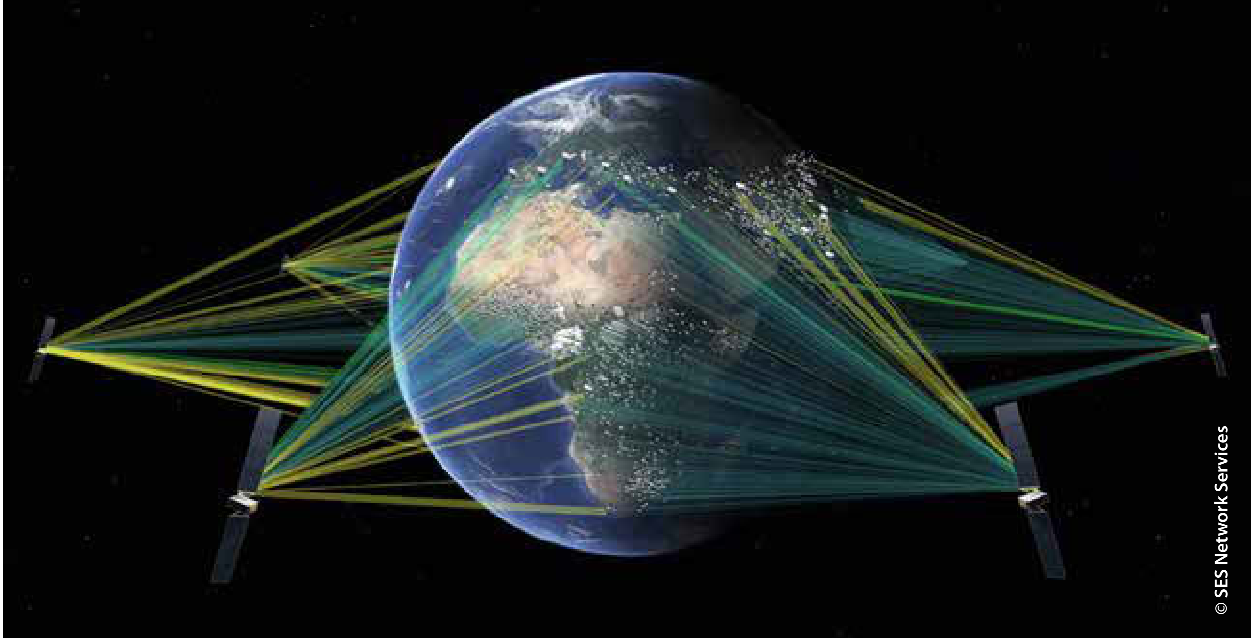
Joint Integration Challenges Stemming from Advanced Layered Defence Systems (A2/AD)

SS-C-5 Stooge (K-300P Bastion-P) • SA-21 Growler (S-400 Triumf) • SS-26 Stone (9K720 Iskander)

JAPCC and Commander Maritime Air NATO co-chair the annual Bi-SC Maritime Air Coordination Conference (MACC), which convenes annually to address Air and Maritime component challenges to foster improved integration. At the last meeting, the participants reviewed the challenges posed by Advanced Layered Defence Systems, commonly referred to as Anti-Access Area Denial (A2/AD), that each component faces. The timing of the MACC 2017 was juxtaposed against real world demonstrations of some of these capabilities, as the Russian Federation began not only installing new elements of the layer (an S-300 SAM system) in Tartus Syria, but also demonstrated to the world the reach of some of their modern cruise missiles deployed from air, surface and below the surface. Kilo class submarines and frigates firing Kalibr cruise missiles from the Mediterranean, corvettes and cruisers doing the same from the Caspian Sea, and the potential installation of advanced Surface to Air Missile systems in Syria were coalescing into a new problem set for the Alliance in the Eastern Mediterranean which required deeper analysis and coordination by the Air and Maritime components.

In the time since the MACC 2017, and building on themes from JAPCC's 2016 Air and Space Power Conference (Preparing NATO for Joint Air Operations in a Degraded Environment), subject matter experts from JAPCC, CAOCs Uedem and Torrejon, Allied Maritime Command (MARCOM) and Naval Striking and Support Forces (STRKFORNATO) have assembled a comprehensive briefing to outline joint integration challenges presented by these types of systems. To date, the JAPCC has provided this brief to the senior leadership of JFC Brunssum and JFC Naples, STRKFORNATO, the Maritime and Amphibious Operations Working Groups, CAOC Uedem, NATO Special Operations command, numerous national staffs and organizations, and finally to the Joint Warfare Centre (JWC), including the team of Senior Mentors who advise NATO leadership during certification exercises, in an effort to build a common knowledge base of the problem and understanding of the integration challenges. The JAPCC has been requested to continue support to NATO's JTF certification exercises and the JWC has been advised by the Senior Mentors Team to include this topic as part of the academics for future exercises.

This brief may be accessed at JAPCC's homepage on NS WAN, and is summarized in an unclassified format in JAPCC's article published in the latest JWC Three Swords magazine, available online at: *http://www.jwc.nato.int/images/stories/threeswords/A2AD_2018.pdf* ●



Resiliency in Space as a Combined Challenge

In this day and age, Space assets have become critical infrastructure not only for the civilian sector but also for the world's militaries. Almost all of today's military operations rely on capabilities enabled by Space systems. To maintain its technological advantage as well as situation awareness and understanding, NATO depends heavily upon Space-based data, products and services such as Positioning, Navigation and Timing, Satellite Communications, Intelligence Surveillance and Reconnaissance, and more.

However, NATO does not own or operate any satellites. Instead, Space-capable NATO Nations offer support with their available Space-based data, products and services. The respective exchange mechanisms as well as the limitations for such Space support are laid down in related agreements, contracts and MoUs with NATO. Most notably, the provided Space capabilities will always stay under national control. That means, if a member country needs its asset for national purpose it can always withdraw the service, which makes the planning and conduct of NATO operations more complicated.

Furthermore, the Alliance needs to be concerned with the reliability of those Space capabilities being made available for supporting operations. On orbit Space systems are exposed to a number of highly probable risks. Physical threats may arise from the Space environment itself, either by the effects of Space weather (e.g. high-energy particle radiation, solar storms, strong temperature fluctuation) or the risk of collision with Space objects like manmade Space debris. On top of these environmental threats, Space systems and their services are vulnerable to intentional adversary counter-Space activities and technology, the development and proliferation of which are ongoing.

Based on a request from HQ AIRCOM, the JAPCC has initiated a study focusing on how NATO can guarantee persistent and federated Space Support to Operations in the current contested, congested and competitive Space environment. The study aims to identify and discuss possible roles of NATO in improving the guaranty of Space data, products and services contributed by the Space-capable Nations. This process would include both, the exchange mechanisms as well as the level of redundancy in Space, also defined by the term 'resiliency'. The release of a White Paper is planned in the second half of 2019. It shall include lessons identified and lessons learned during upcoming NATO joint exercises, whose playbook will include a proper number of such challenges with regard to Space Support to Operations. ●

JAPCC Vision on a Future Battlefield Rotorcraft Capability (FBRC)

Preparing for the next rotorcraft generation will be one of the toughest challenges that NATO faces in the next 15–20 years and beyond. Within the 2030–2035 timeframe many of NATO's medium lift helicopters will be due for replacement and many allies are due to refurbish or retire their current helicopter fleets. Future rotorcraft designs must be based on new technology and materials, faster motion, greater range and payload, better reliability, and superior interoperability concepts. Therefore, NATO's future rotary-wing capabilities should not consist of the acquisition or upgrade of single helicopter models alone. It will rather require a comprehensive replacement of entire helicopter fleets. This will have huge financial implications and should therefore be based on prudent capability planning.

The JAPCC is committed to fostering the development of an overarching future rotorcraft concept and pursuing the transition from strategic analysis and technological developments into operational concepts and capability requirements for 2035 and beyond. At the request of the Italian Air Force, the European Personnel Recovery Centre, NATO Air Command and the Air Development Program of NATO Special Operation Headquarter, the JAPCC conducted a study called 'Future Battlefield Rotorcraft Capability anno 2035 and beyond'. During the process of elaborating this study, JAPCC shared perspective with NATO organizations and industry on the importance of rotorcraft for future military operations, developing strategic foresight and a common understanding of the required capabilities. In addition, an operational analysis was conducted to define future helicopter requirements from a tactical user perspective to allow optimal platform engineering for the FBRC.

Based on the results of the study, a JAPPC whitepaper will be published at the end of June 2018, providing an independent analysis of how the battlefield environment of 2035 and beyond could shape future rotorcraft capability. In the unique context of the Alliance, some of the major requirements will be highlighted in this publication, thus offering food for thought for NATO organizations and Allied Nations. ●

The JAPCC Annual Conference 2018

The JAPCC invites you to attend the 2018 Joint Air and Space Power Conference in Essen, Germany, from 9–11 October. Our internationally-renowned annual conference provides an interactive forum for delegates to exchange ideas and perspectives on Joint Air and Space Power topics. It has attracted senior military, political, industry and academia leaders with attendance of over 100 flag officers, including Air Chiefs, in the last three years.

In previous annual JAPCC Conferences, many aspects of Joint Air Power related to deterrence were comprehensively discussed: *'Air Power and Strategic Communications'* in 2015, *'Joint Air Operations in a Degraded Environment'* in 2016, and *'The Role of Joint Air Power in NATO Deterrence'* in 2017. It is therefore entirely appropriate that this year´s Conference is dedicated to examining the indicators of failing deterrence, and the situation when deterrence fails, which is when Joint Air and Space Power's speed, agility and flexibility are needed as part of NATO´s first response to a crisis or war. **'The Fog of Day Zero – Joint Air & Space in the Vanguard'** was hence adopted as this year´s Conference theme.

The Conference will discuss what it means for Joint Air & Space Power to be able to fight on 'Day Zero' and raise the question if we are sufficiently prepared. While 'Day Zero' is not an official term it can be thought of as the early phase of a confrontation in which both overt and obscure application of instruments of national power may be undermining the Alliance and setting conditions for armed action by an adversary. The 'Fog of Day Zero' implies that there might be difficulty not only in recognizing these activities, but in determining how to respond with NATO air and space power to hostile actions that are recognized but remain below the threshold for an Article V response. The conference will be organized as a symposium divided in panels basically following these four themes:

1. The 'Day Zero' Threat Environment: Modern Threat Vectors, Adversary Shaping Operations, and the Article V Threshold.

2. Joint Air and Space Power in the Vanguard of NATO's Response: Capabilities, Vulnerabilities and Challenges.

3. Does NATO have the Required Mindset to Fight on 'Day Zero'?

4. How can NATO Address Emerging Security Challenges Using Air and Space Power?

This year's conference expects to bring together top experts from various spheres to encourage debate and audience engagement. It is essential that we enhance our understanding and improve our capability to deal effectively with a 'Day Zero' situation, hence increasing the probability that deterrence will not fail. We look forward to seeing you there.

Further read-ahead material as well as registration information can be found online at:

https://www.japcc.org/conference/

'Air Force Blue – The RAF in World War Two'

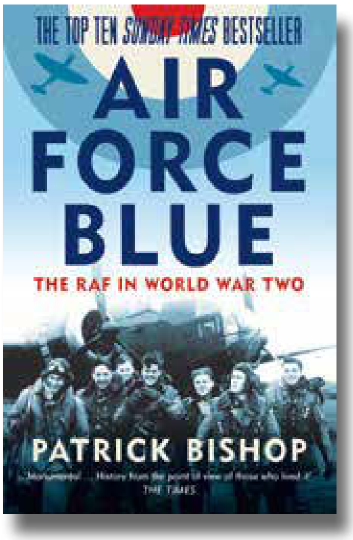


Photo © Hulton-Deutsch Collection/CORBIS/Corbis via Getty Images

By Patrick Bishop, HarperCollins Publishers, 2017

Reviewed by:

Lt Col Ed Wijninga, NLD AF, JAPCC

Created on 1 April 1918 through a merger of the Royal Flying Corps and the Royal Naval Air Service, the Royal Air Force (RAF) is celebrating its 100th anniversary this year. Written for this occasion, *'Air Force Blue'* is a book that celebrates the history of the RAF through reference to diaries, memoirs, anecdotes and interviews. It provides a detailed view of the early years of the junior service and describes how the RAF went through the struggle for survival in the period between the two World Wars. It explains how the RAF got its roundel and how the RAF's blue uniform became the model for many other countries' Air Force uniforms. The book furthermore examines the significant merits of Sir Hugh Trenchard, the so-called 'Father of the Royal Air Force'.

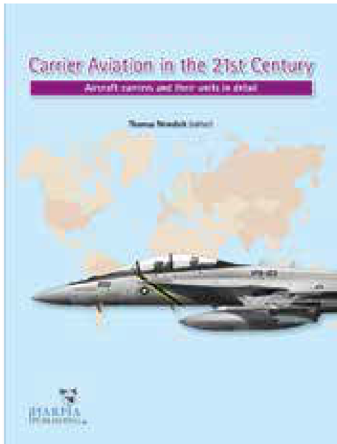
'Air Force Blue' stands as a testament to the men and women who built the Royal Air Force during its formative years and sustained it through the dark days of the Second World War, at the end of which 1.2 million personnel served in various RAF formations, to include the so-called 'Trenchards Brats', 'Brylcreem Boys' and the 'Women's Auxiliary Air Force'. All these shared the glamour, the fame but also the trials and tribulations of what became one of the most respected Air Forces in existence. Renowned RAF Historian Patrick Bishop has conducted very new and detailed research to compile this tribute to 100 years of the RAF. Already a best seller and destined to be a classic book on military history, this book is highly recommended. ●

'Carrier Aviation in the 21st Century'

'Carrier Aviation in the 21st Century' is both an informative reference and repository of fascinating aircraft carrier history. This book reviews past ambitions and speculates on future aspirations for each country currently operating fixed-wing carriers, namely: Brazil, China, France, India, Italy, Russia, Spain, United Kingdom, and the United States. Each chapter is written by a country-specific subject matter expert. The book maintains a fluid and easy-to-read style throughout.

Every aircraft type (fixed and rotary wing) employed on aircraft carriers is included, with information on anticipated future upgrades and on operational challenges. Details on carrier-based variants of fifth-generation aircraft, including operational and tactical considerations, provide the reader with insight into how these aircraft will revolutionize future maritime air power. The book also explores the challenges associated with the carriers themselves, including maintenance schedules, operational deployments, sortie generation capabilities, and schematics of theoretical carrier battle groups. The most interesting portions of the book are the reasons for key regime choices (including Russia and China) and how they have influenced current capabilities, ambitions, and maritime air postures of those respective countries.

Overall, *'Carrier Aviation in the 21st Century'* is highly recommended for all military aviation aficionados and a 'must-read' for carrier aviation enthusiasts. ●



By Thomas Newdick, Harpia Publishing L.L.C., 2017

Reviewed by:

Cdr Daniel Cochran, USA N, JAPCC