Transforming Joint Air and Space Power

The Journal of the JAPCC

Edition 29, Winter 2019/2020

ALONE WE'RE TOUGH. TOGETHER UNBEATABLE.

WE MAKE IT FLY

European air sovereignty will prevail thanks to the Future Combat Air System. At its heart is the Air Combat Cloud. By combining platform capabilities, it makes any military operation more powerful than the sum of its parts. Developed by Airbus and its European industrial partners, it means a stronger Europe ready to face any threat independently.

Connectivity. We make it fly.

airbus.com

AIRBUS

It was my distinct pleasure to lead the JAPCC team in organizing and hosting this year's Joint Air and Space Power Conference: **'Shaping NATO for Multi-Domain Operations of the Future'.** This annual gathering drew more than 320 Air and Space experts from 27 nations and multiple NATO and European organizations, including more than 60 General/Flag Officers and senior civilian leaders. We are already working hard on the 2020 conference, which will address **'Leveraging Emerging Technologies in Support of NATO Air & Space Power',** and we hope to see you again in Essen as we dig into one of the main challenges to keeping Alliance Air and Space Power relevant and able to sustain Alliance Defense, Deterrence and Security for decades to come.

In the meantime it is my pleasure to present this 29th edition of the JAPCC Journal, *Transforming Joint Air and Space Power*. This offering opens with an assessment by the JAPCC Director and Commander, Allied Air Command, General Jeff Harrigian, of what he considers the three main elements of Multi-Domain Operations and how the relevant evolution of Command and Control will shape our future. It is immediately followed by an interview with the Chief of Staff of the Italian Air Force, General Alberto Rosso, who offers us great insights into the challenges facing the Italian Air Force, its priorities, and where Italy is leading the way in next generation evolution and integration.

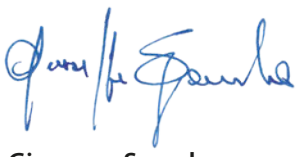
'Air Command and Control in NATO' provides historical insights into Operation Unified Protector and lessons for NATO's current level of ambition. It is followed by three articles addressing the newly recognized space domain: 'New Space', 'Congested Outer Space' and the importance of 'Space Support in NATO Operations'. Next we present two articles expanding on the topic of our October conference, highlighting 'Multi-Domain Operations' and a 'Multi-Domain Approach to Targeting'.

'Joint Personnel Recovery 2040' provides an update on an ongoing Multinational Capability Development Campaign project, while 'Manned – Unmanned Teaming', 'Comprehensive Approach to Countering Unmanned Aircraft Systems', and 'The electromagnetic Environment and the Global Commons' examine issues of concern likely to be addressed in the 2020 conference.

'Small Nations in Joint Air Power' explores the ways nations with small air fleets provide value to NATO and 'Strategic Value of Aircraft Carriers' is a cost-benefit analysis of aircraft carriers for future conflicts, while in the final article the deputy commander of the European Air Transport Command, Brigadier General Francesco Agresti, describes the success story of EATC in expanding Alliance air mobility capacity.

I want to thank you for reading, and our authors for contributing. I hope you find the articles in this Journal as informative and thought-provoking as I did. The JAPCC team greatly appreciates your feedback and thoughts. Please visit our website at www.japcc.org, one of our social media pages, or send us an e-mail to contact@japcc.org to give us your opinion.

Ciao and good reading!



Giuseppe Sgamba
Brigadier General, ITA AF
Assistant Director, JAPCC

The Journal of the JAPCC welcomes unsolicited manuscripts.
Please e-mail submissions to: contact@japcc.org

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

Current and past JAPCC Journal issues can be downloaded from www.japcc.org/journals

The Journal of the JAPCC Römerstraße 140 | D-47546 Kalkar | Germany

Table of Contents

Out of the Box

Inside the JAPCC

Book Reviews

Imprint:

Transforming Joint Air & Space Power: The Journal of the JAPCC

Director
Joint Air Power Competence Centre
Gen Jeffrey L. Harrigian

Executive Director
Joint Air Power Competence Centre
Lt Gen Klaus Habersetzer

Editor
Brig Gen Giuseppe Sgamba

Assistant Editor
Lt Col Daniel Wagner

Production Manager/
Advertising Manager
Mr Simon J. Ingram

Editorial Review Team
Col Brad Bredenkamp
Lt Col Panagiotis Stathopoulos
Mr Adam T. Jux

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.

Disclaimer
The views and opinions expressed or implied in the JAPCC Journal are those of the authors concerned and should not be construed as carrying the official sanction of NATO.

Terms of Use
Unless particularly stated otherwise, all content produced by JAPCC Journal authors is not subject to copyright and may be reproduced in whole or in part without further permission. If any article or parts thereof are being reproduced, the JAPCC requests a courtesy line. In case of doubt, please contact us.

The JAPCC Journal made use of other parties' intellectual property in compliance with their terms of use, taking reasonable care to include originator source and copyright information in the appropriate credit line. The re-use of such material is guided by the originator's terms of use. To obtain permission for the reproduction of such material, please contact the copyright owner of such material rather than the JAPCC.

M **Denotes images digitally manipulated**

Follow us on Social Media


© Lockheed Martin

Shaping the Future Multi-Domain C2

By General Jeffrey L. Harrigian, USA AF, Director JAPCC

In the seven months since I took command of Allied Air Command, I have had the opportunity to travel across the European continent to see Air Power at work. I have seen tremendous work done by the outstanding men and women of our Alliance Air Forces, both within Europe and North America, and beyond. The efforts made every day to deter potential aggressors and provide increased stability along NATO's borders left me both humbled and proud to be a part of your team.

Allied Air and Space Power is entering a new era of increased speed and digitization. The systems we develop and operate to secure, defend and control the Air domain are more reliant on Cyber and Space-based capabilities than ever before. They enable us to connect, make decisions, and respond at speed to a spectrum of evolving threats from high-end peer competitors to Violent Extremist Organisations (VEO).

However, as our capabilities evolve, so does the threat we may face in the future. We must maintain momentum. We need to continue to improve our Joint Command and Control systems and fully network them across the Air, Land, Maritime, Cyber, and Space domains. Multi-Domain Operations and relevant Command and Control (MDO/MDC2) will shape our future. We must now take steps to maintain our advantage and initiative.

The challenge is to move from today's operations across all domains to tomorrow's Multi-Domain Operations. MDO was the theme of our annual Joint Air and Space Power conference held by the JAPCC this fall. As the Director of JAPCC, I want to open this 29th edition of our Journal with my thoughts on the outcomes of this conference and the three elements of MDO: Connecting, Decision Making and Responding at Speed.

The return of inter-state strategic competition is shifting our modern warfighting approach. Technologies associated with adversary threats continue to evolve. Advancements exist not only in traditional kinetic weapons like hypersonic missiles, but also in non-kinetic capabilities. Weapons now manoeuvre in and through cyberspace and are able to generate terrestrial effects from space. By recognizing the complexity of our operating environment and leveraging technological advances, we ensure that we stay at least one-step ahead of our adversaries across our full range of capabilities. The ability to present multiple and simultaneous dilemmas to our adversaries will overload their capacity to react and allow us to maintain the initiative.

It all starts with connectivity through a fully networked force. Sensors exists across every domain, but connecting those sensors remains challenging. As we think about existing and developing sensors, we must connect them to form a cohesive, resilient and self-healing collective network. Therefore, it is crucial that we build in multi-domain interoperability from early design with any future capabilities.

We have also made great progress in the field of datalinks that enable us to disseminate and exchange information across domains and services, but significant work remains. Earlier this year, Link 16 became the NATO Minimum Military Requirement. The sharing of information through datalinks will heavily augment situational awareness in future conflicts. As one of our NATO Air Chiefs stated during the JAPCC conference, victory will depend on the strength of our interconnected networks. As datalink capabilities continue to become 'standard' across our forces, we must challenge ourselves to use them in daily training. Persistent datalink use will set the foundation for follow-on networked solutions. We cannot rely only on what we have today. Rather, we must strive to have state-of-the-art datalink networks in the future that will enable 5th generation systems, improve sensor fusion and allow us to harness big data.

However, network connectivity is only the first step. We have to ensure we fuse the information collected by our network of sensors in ways that facilitate rapid sharing. This agility will lead to faster decision-making, eventually pairing the appropriate effect (whether kinetic or non-kinetic) with the right target. We must do this through agile software development that leverages Artificial Intelligence and automation. To make this happen we need to develop capabilities fast, and I mean in the next couple of years, as waiting for 2040 is too late. We need to embrace our industry partners and have an incremental and modular approach. We must develop new tools faster than our traditional military processes permit, in order to sustain the speed of relevance. Tomorrow's joint leaders need to understand all domains sufficiently to be able to optimize the capabilities we develop and bring them to bear in the most effective and efficient manner. This will include transitioning from humans 'in-the-loop' to humans 'on-the-loop'. Tomorrow's leaders have to maximize emerging technologies while managing operational risks and the moral and ethical challenges of automation.

'We must develop new tools faster than our traditional military processes permit, in order to sustain the speed of relevance.'

Connected networks, informed decision-making and the ability to respond at speed are all critical capabilities as we seek to leverage existing and emerging technologies in support of NATO Air & Space Power. I am excited to explore new possibilities and technologies with the knowledge that this exploration will occasionally mean failing … and that has to be okay. I offer to you that the importance of continuing to challenge our assumptions is instrumental to our ability to maintain momentum. We must always foster a culture of innovation. We need to listen to our younger contributors, the junior officers and enlisted men and women closest to the fight. They are going to bring forward the great ideas that we, senior leaders, cannot afford to ignore if we want to remain relevant.

We must evolve our alliance into the connected, Multi-Domain fighting force that future conflicts require. We need to be agile and act at the necessary speed to maintain our advantage and our freedom of action.

I have great confidence that amongst our nations and partners, people are going to figure out the best way forward. It is not going to be easy. I look forward to working with you to bring these future possibilities into operational reality, with the requisite training and exercises to enable mission success.

Finally yet very importantly, I would like to recognize that the challenges mentioned above are less daunting because of the quality of people serving in both the NATO Command Structure and the supporting organizations like the JAPCC and other COEs. The personnel investment in these organizations yields fantastic synergy. This helps us transform NATO Air and Space capabilities into the future force we need to ensure we continue to deter our adversaries and defend NATO's territory. Keep up the great work and let's get after it! ●

General Jeffrey L. Harrigian

is the Commander, US Air Forces in Europe; Commander, US Air Forces Africa; Commander, Allied Air Command, headquartered at Ramstein Air Base, Germany; and Director, Joint Air Power Competence Centre, Kalkar, Germany. He is responsible for the air and missile defence of 29 NATO alliance member nations and commands US airpower across more than 19 million square miles in an area that includes 104 countries in Europe, Africa, Asia and the Middle East and the Arctic, Atlantic and Indian Oceans.

General Harrigian has served in a variety of flying and staff assignments, including Deputy Director for Strategy, Plans and Assessments, US Forces-Iraq, in support of Operation Iraqi Freedom and as Chief of the Joint Exercise Division at NATO's Joint Warfare Center, Stavanger, Norway. He has flown combat missions in support of operations Just Cause and Desert Storm. He also served as the Commander, US Air Forces Central Command, Combined Force Air Component Commander US Central Command, Southwest Asia.

General Harrigian was commissioned in 1985 from the US Air Force Academy and is a command pilot with more than 4,100 hours in the F-22, F-15C, A/OA-37 and MQ-1 aircraft.

Embracing Transformation

An Interview with Lieutenant General Alberto Rosso, Chief of the Italian Air Force

Since you took over your position as the Chief of Staff of the Italian Air Force in late 2018, what do you think will be the challenges and priorities the Italian Air Force needs to address?

Since its origin, Military Aviation has been faced with two challenges: how to effectively counter the air capabilities of the adversary and how to generate and integrate effects across the land/sea battlefield. Now, while the first challenge is common to the other services, marking their strategic relevance in their respective domains for the National Defence, the former seems to be more of an issue for the Air Force. In fact, it is undeniable that only the Air Force serves a purpose other than for itself, in order to enable the other components' manoeuvre and operations. As a proof of that, jokingly, we could observe that while we have Joint Strike Fighters, Joint Direct Attack Munitions, Joint Tactical Air Controller, we do not have joint battle tanks, joint frigates, joint artillery or joint land/sea controllers …

These two challenges still exist today and, although not altered in their essence, they are exacerbated by the steep rate of technological innovation.

With regard to the air battle and the ability to counter potential adversaries, for example, we must consider that today's new frontiers of hypersonic flight and sub-orbital operations will be tomorrow's potential battlefield. Furthermore, ill-intentioned actors are already employing swarms of drones to carry out attacks on critical infrastructures. So our attention and our best resources must be focused on staying ahead of any possible threats that might come from these and many other new technologies. At the same time (if not earlier), we must be able to effectively employ new technologies, and this, in turn, brings about several new challenges. As we innovate and adopt new systems (whether defensive or offensive), we will be faced with the constant task of integrating legacy and new generation weapon systems. This is happening

today, as we speak. Our legacy fleet, mostly 4th generation aircraft, is being pushed above and beyond what was thought possible just a couple of years ago. So, as our 5th generation systems are progressing along their own path of excellence, a considerable amount of time and resources have to be dedicated to 'keeping everyone in the game', because the interoperability of our own force elements is key for operational effectiveness and success.

This leads us to the second challenge: creating, delivering and integrating effects not only in the land and sea battle, but in (and through) the cyber, EW, sub-orbital and space domains. The ability to be effective in the scenarios that lay ahead of us requires a lot more than just technology, it demands a whole new mindset: a 5th generation transformation of the whole Air Force. The ability to gain and maintain information superiority will be necessary, but not sufficient, to ensure that we will always stay one or more steps ahead of potential adversaries. The quality, timeliness and reactiveness of our decision cycles must also improve. We must move from information superiority to decision superiority. Being able to sift through huge amounts of readily available information and orient the application of air power with speed and precision will be our 'next level' challenge. Effective strategic decisions will have to be enabled at the tactical level, if we want to stay one step ahead of our opponents. Even if we excel at creating a decisional advantage in the multi-domain battlespace, that might still not be enough. We also have to reconsider the way we plan and execute joint operations. The way we go about it today relies on Air Power's ability to create air supremacy/superiority before any other activity is carried out on the ground. Future scenarios will not grant the same luxury. Supremacy will be impossible and superiority will be, at best, temporary. In these narrow windows of opportunity there will be no time to integrate the effects that each component planned in its own campaign: the effects must be 'fused' at the origin, as part of one unique and coherent decision process and delivered simultaneously before the window closes. The whole idea of joint operations might have to evolve into that of 'fused operations', and that is some very interesting food for thought!

Access to Space is among the current hot issues. What is the Italian Air force approach to exploit this new frontier?

Italy has been at the forefront of the European space endeavour. The Italian Air Force has pioneered this new frontier from the beginning, partnering in the Italian space program with Rome's 'Sapienza' university and with the National Research Center since 1962. The IT AF took part in the successful launch of the first Italian satellite 'San Marco 1', on December 15th 1964, which marked Italy's entry into the Space Age, the third nation in the world following the USA and the USSR. It has been a long series of successes ever since, and the Air Force contribution to the Italian space strategy is still of great relevance today. For example, 5 out of the 8 Italian astronauts today are Air Force Officers.

Having said that, space is not about history! When we look at issues dealing with space, we are looking at what, from an economic, security and defence standpoint, is becoming the primary physical enabling domain of human activity (sharing that role with the 'non-physical' cyber domain). In light of its relevance for security and defence, we therefore need to possess complete space situational awareness, and be able to protect the critical assets, ensuring the resilience of data, products and service from space. As an Air Force, we are taking a comprehensive approach and, therefore, we interact not only with military entities but also with academic and scientific research bodies and national industry. The Italian Air Force is fully involved in national space strategy, in particular through applications and research projects, as well as bilateral and multinational cooperation. This approach also contributes to preserving and increasing the knowledge of the national aerospace industry.

Space, Aerospace and Access to Space are concepts that will influence the way we think of operations in the future. While outer space (beyond the Karman line, at 100 km of altitude) might have several claims on which Armed Service (if any) should preside over it, the Air Force sees the Aerospace Belt (between 20 and 100 km) as the natural extension of the 'airspace' in which we operate today. I am convinced that new technologies will soon allow suborbital flight to take

place in this portion of space and therefore, in the future, humankind will be able to use this layer to pass seamlessly from the air to space domains.

In fact, alongside Italian defence industry, we are currently paving the way for innovative aerospace programs, such as the launch of mini-satellites through high-performance aircraft, the effective use of stratospheric platforms for military purposes and the creation of spaceports for suborbital hypersonic flights.

Lastly, with regards to access and use of Space and Aerospace, I think our robust knowledge and experience in airspace control procedures will be extremely valuable in supporting the Civil Aviation Authority's efforts to create safe and effective regulation, similar to what we did to allow RPA flight operations in civilian airspace, as I will discuss later.

How do you evaluate Italy's position in the F-35 project?

With the F-35 program, the Italian Air Force has embraced the evolution to the 5th generation. We have already covered some of the implications of this 'technological and cultural shift', as I highlighted the challenges of co-existence of 5th generation platforms with legacy systems. Now I would like to emphasize why the main pillars of the 5th generation paradigm are so important for the relevance of our Air Force within the evolving scenarios.

Low Observability, a state-of-art sensor suite and stand-off ranges are key features in countering potential opponents with like-capabilities. These are vital elements that fit within NATO's posture and, therefore, they make our contribution to the Collective Defence credible and reliable.

'Omni-role capabilities' allow the optimization of performance in operations (especially deployed), massively reducing the logistics footprint, enabling light and agile responses, while increasing sustainability of our efforts. When I say agile, I mean adaptive and capable of accomplishing a wide range of tasks and offering highly scalable effects, which vary from mere deterrence to effective use of surgically precise weapons.

© Italian Air Force

More than ever before, data fusion technology offers the opportunity to directly receive on board and merge in real-time information from various sophisticated sensors, to generate a clear situational awareness and information superiority which favours specific missions and the effectiveness of joint forces. And that is not all. Alongside data fusion, we have an incredible capacity to distribute information, which in turn enables and enhances the operational envelope of legacy weapons systems. We are actually pioneering this way of bringing legacy systems into a 5th generation warfare scenario. As we progress, we are finding that, with proper and detailed TTP's, you can have the whole spectrum of 5th generation actions and effects delivered by a balanced mix of legacy and 5th generation systems. We call this '5th Generation Transformation'.

Airborne air battle management capability, which can be considered the combined result of all the previous pillars, is the translation of the idea of strategic decisions at tactical level which I referred to before. It enables that much needed Decision Superiority that allows us to stay ahead of our opponents. Up until now, our legacy systems (and processes, I daresay) have been managed in a Centralized Control – Decentralized Execution paradigm. In the 5th generation world, both Control and Execution can (and should) be decentralized.

This might help to explain why we put so much effort in reaching all the milestones of the program ahead of time: first flight of an aircraft assembled out of the USA, in November 2015; first transoceanic flight, in February 2016; first operational Airbase outside of the US, in December 2016; full integration within Italian IAMD, in March 2018; first partner nation to declare IOC, in November 2018; first nation to operationally deploy the F-35 in a NATO operation in Iceland in October 2019. These are the Italian Air Force's and the Nation's most evident and convincing indicators of the level of conviction and commitment to the F-35 project.

Thanks to the relevance of RPA's current contributions to operations and the even higher expectations for their future utilization, they have lately been playing an essential role in every discussion concerning the future capabilities within NATO. How does the ITAF plan to integrate the RPA capability into its core business?

The Italian Air Force has always been a strong believer and a dedicated operator of Remotely Piloted Aircraft. In the early times of RPA's, when the idea of piloting from the ground was considered almost heresy, we took bold steps in order to incorporate RPA operations into the Air Force's concept of operations, and it paid off. We were among the first nations in Europe to operationally employ the MQ-1 Predator, in January

2005 in Iraq. Since that time, we have been constantly expanding the operational envelope of our RPAs. We quickly moved from autonomous land surveillance flights to full integration of RPA's in Composite Air Operations (COMAO's). We have also pioneered Remote Split Operations, land-away operations and laser designation. From the beginning, we worked closely with our Civil Aviation Authority in order to regulate the coexistence of traditional and remotely piloted aircraft in the national airspace structure. Lastly, we frequently operate RPAs for Homeland Security purposes, such as surveillance for high visibility events (summits, G7-G8-G20, Catholic Jubilee, etc.) and Environmental Protection.

The truth is that our RPA capability is more than integrated into our core business! As a matter of fact, the integration of RPA operations has been one of the main drivers of change to our operational framework in the last 10–15 years. We have, by far, the most benign airspace structure and procedural framework to accommodate RPA ops. We have a very effective Processing, Exploitation and Dissemination (PED) cell, which is already integrated within EUCOM and CENTCOM distributed PED network and will soon be included within the NATO AGS framework.

Speaking about NATO AGS, and taking into account the experience Italy has developed in RPA management, it is not surprising that NATO turned to Italy to certify the Alliance Ground Surveillance (AGS) system, which will operate from Sigonella airbase. The Military Type Certification recently obtained by AGS is a major milestone, which will allow the platform to access the Italian and European airspace structure and enjoy the same benefits as the Italian RPA's. This is the first case ever in which a High Altitude Long Endurance (HALE) system has been granted such a certification. We devoted much effort to making this achievement possible, and we will invest much more to ensure that all 5 aircraft, planned to arrive between 2019 and 2020, will reach full operational capability (FOC) in 2022 as expected. I believe that AGS will provide the Alliance with a superior and more persistent ISR capability and consequently a greater level of 'information dominance'. Furthermore, the combination of manned and unmanned ISR and combat platforms will enhance military options that, together with a top tier level of command and control underpinned by a strong data-link network, will allow commanders to achieve the military campaign's goals.

As a commander, what are your main concerns regarding the training of Airmen under your leadership?

Human resource management is one of the main challenges we have. It represents the core business of the modern organization in a globalized and competitive world. What characterizes an Air Force is technology and innovation, so our personnel must be able to manage this challenge. Therefore, one of the Commanders primary responsibilities is to provide the best education and training possible for their personnel.

Innovations require new mindsets, new skills and often significant adjustments to master modern technologies and, therefore, my main concern has been to provide my airmen with the best tools for the training environment, as close to the real world as possible. This is precisely what happens for military flight training, which has always been a fundamental goal for the Italian Air Force. The quality of our instructors and the excellence of our training tools and programs are internationally recognized and highly appreciated.

As a matter of fact, in close synergy, the Italian Air Force and the aerospace industry are implementing a new state-of-the-art Integrated Training System (ITS), which is based on the close coordination of Live and Virtual elements that interact in a Constructive environment (LVC). At the core of this system lays the T-346 advanced trainer aircraft, which was specifically designed to fulfil the advanced training requirement of 4th and 5th generation fighter pilots. The aircraft is part of a larger community of ground-based training tools (emulators and simulators) with which it can interact during flight, thus allowing the optimization of training and a significant saving of resources. Just to give an idea, 2 aircraft and 2 simulators can perform a mission of up to 12 aircraft with an unbelievable degree of realism! Due to its characteristics, the T-346 based training is capable of achieving two significant added benefits: it considerably reduces the training burden of frontline squadrons, in consideration of the higher exit level of pilots;

and can be employed as 'companion trainer' for those same units, thanks to its similarity with 4th and 5th generation aircraft. The combined effect of these factors, in turn, allows us to free up resources for the operational employment of our 4th and 5th generation fleets.

Inspired by the same philosophy as the ITS, but devoted to the earlier stages of pilot training, is the T-345 basic jet trainer aircraft: a modern trainer that was born from the challenge (accepted and won by the Italian aerospace industry) to produce a jet trainer at the same cost as a turboprop airframe. We aim to deliver the first course in January 2022.

Italy, as a valuable member of NATO, participated in several operations. How do you interpret the Italian contribution to these operations and the importance of the Alliance's synergy?

I'm personally convinced that NATO is and will remain the cornerstone of allied security and defence for the foreseeable future. Having said that, decades of Peace Support Operations might have led to questioning the need for (and sometimes even the existence of) the Alliance. Today's scenario appears different, however, and while the asymmetric and terror threats still exist, we also observe a resurgence of tension and instability among state-actors. In light of these trends NATO is and will be pivotal to our collective defence and security: no single nation can cope with the kind of risks and threats that lurk just over the horizon, and only within NATO's core tasks can we all find the reassurance of deterring and/or effectively countering such threats. If that implies that nations might be called to project forces into regions that don't seem to pose an actual and immediate threat to their specific interests … so be it! We can consider this an 'insurance' premium we all have to pay, in order to be covered when the 'real' emergency arises.

We believe in 360° vigilance and protection for and by NATO, so although Italy's most urgent and pressing risks come from the Mediterranean Sea, we (Italy, and the Italian Air Force in particular) have been doing more than our fair share in feeding NATO's Deterrence & Defence posture, by regularly covering slots of Air Policing on the Northern and Eastern flanks of the Alliance. We are so convinced of the necessity of this task that, not only did we do everything in our power to deploy the F35's in Iceland last October, but, as of 2020, we are formally bidding to fill 3 quarterly slots of Air Policing operations every year in support of NATO's deterrence posture. Along this same line of reasoning, we also expanded our initial commitment to the NATO Readiness Initiative to reach a total of 40 combat aircraft and several enablers.

Another fundamental aspect of our commitment to the Deterrence & Defence posture is the participation of the Italian Air Force in the main NATO exercises. This not only allows us to train Italian personnel in accomplishing joint and combined operations, but also guarantees greater interoperability of systems and procedures among the military forces of the Alliance. In addition to this, we have been seeking and exploiting every opportunity to perform common training activities, in particular during the Air Policing deployments. These are facts that clearly substantiate our strong commitment to the Alliance.

To conclude, how do you see the Italian Air Force in the future?

We pretty much covered it all so far, didn't we? We described what the Italian Air Force will look like from the outside: a quality contributor to NATO's posture with a highly capable force, fully projected into the 5th generation. Looking to the future, we will be capable of facing threats from state and non-state actors, from

legacy and new domains; equipped with state-of-the-art technology and fully invested in the task of integrating, or rather, fusing effects with our sister components. We are highly committed to expanding the envelope of RPA operations and our ISR capabilities, while leveraging our outstanding training system to deliver first-class aircrews to all partner Nations.

So my final words will be dedicated to sharing with you how I see the future Italian Air Force from the inside.

Smaller and more agile, it's inevitable that in the next 5–10 years we will lose a huge number of highly skilled and experienced airmen. They will take away with them some of what the Air Force is today. It will be sad and painful, but will it be destructive? I think not. Our younger recruits look promisingly in tune with the type of technology that we are about to embrace. In my view, they will be able to create agile and timely responses to the challenges we mentioned earlier or even to newer threats we cannot imagine today.

Motivated and committed, the generations of airmen that preceded us were focused and determined. They had clear enemies and built the Air Force based on that vision. My generation inherited that vision and that Air Force. We were disoriented at first by unexpected changes that brought about scenarios we never imagined, but then we coped, we transformed and we learned. We handover to the next generation the results of our learning and the ideas that go with it. Not just the technologies, although they are a fundamental part of it, but a mindset that will allow the future Air Force to face successfully a wide array of threats, some of them new and unpredictable. Motivation and commitment will be our winning tools.

Unsurprised and fit for purpose. Rather than a checklist or canned Response Options (like the ones we found at our Squadrons during the Cold War) our future operators will have an open mind and open system approach. They will have the ability and the opportunity to experience and experiment with every possible occurrence: Artificial Intelligence and advanced simulation will greatly enhance our preparedness and reduce the margin for unexpected threats. Furthermore, multi/omni-role weapon systems and advanced logistics and will ensure that, no matter when or where or how a threat to the Alliance emerges, we will be postured to face it.

I am proud and honoured to serve today's Italian Air Force and I'm optimistic about the energy, motivation and competence of the younger generation: they represent our future and I firmly believe we will be in good hands.

Sir, thank you for your time and your comments.

Lieutenant General Alberto Rosso

is the Chief of Staff of the Italian Air Force and he spent the majority of his operational career as an Air Defence fighter pilot.

Assignments:

1978–1982: Air Force Academy

2002–2004: Wing Commander, 4th Fighter Wing; responsible for the transition of the first Italian Air Force Fighter Wing from the legacy F104 aircraft to the Eurofighter Aircraft (EF2000)

2004–2007: Chief, Alliances Policy Office, Policy and Planning Division, Defence General Staff

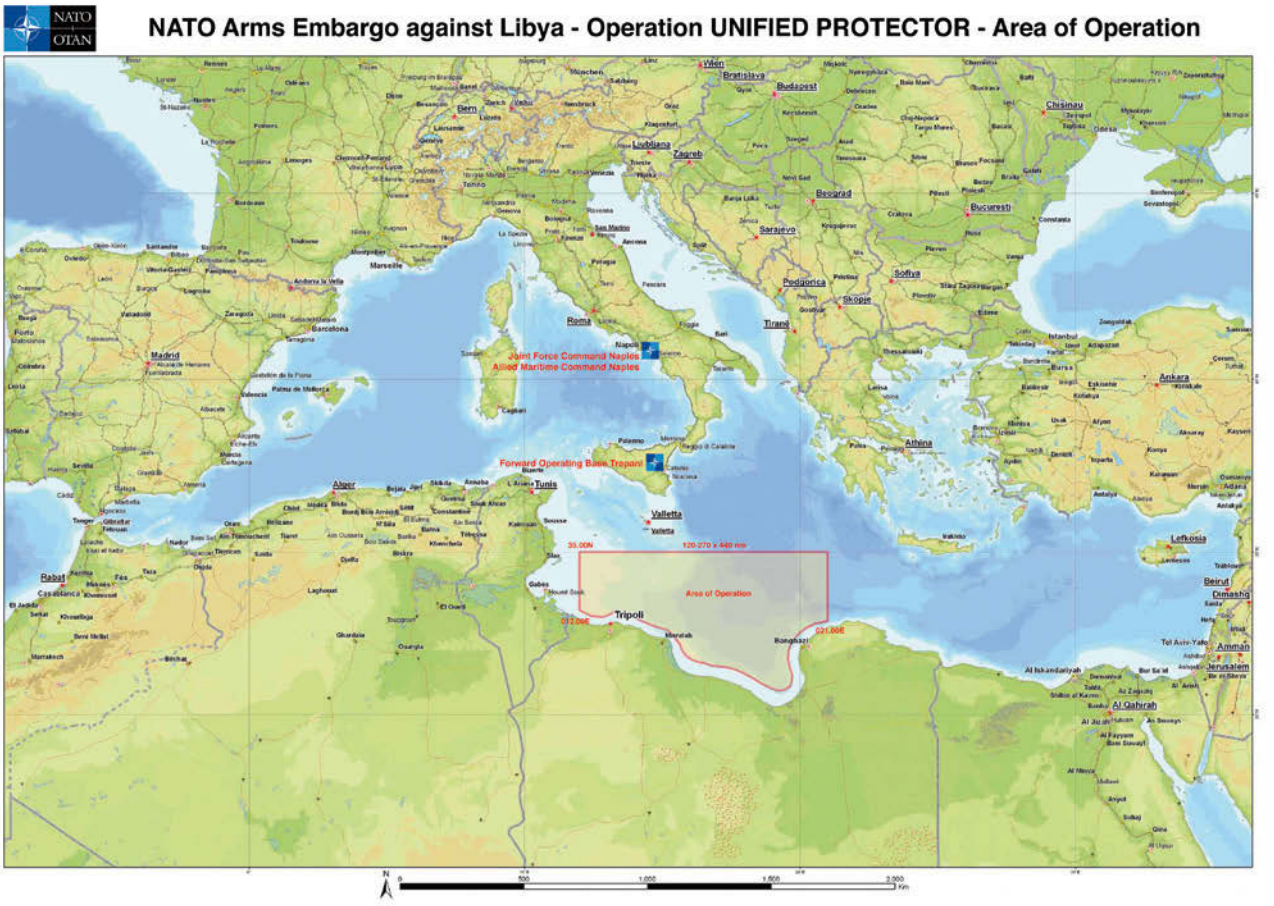
2008–2010: Deputy Chief, Policy and Planning Division, Defence General Staff

2011–2013: Chief, 4th Department, Italian Air Force General Staff

2013–2015: Chief, Logistic and Infrastructure Department, Defence General Staff

2016–2018: Chief, Cabinet of the Italian Defence Minister

October 2018–actual: Chief of Staff of the Italian Air Force



© NATO

Air Command and Control in NATO

The Challenges During Operation Unified Protector

By Lieutenant Colonel Asger Pilgaard, DNK AF, JAPCC

Introduction

This article will discuss the Air Command and Control (Air C2) organisation in NATO with regard to Operation Unified Protector (OUP) in 2011. It will focus on recognizing the challenges from the Air Campaign, which ended 31 October 2011. Specifically, the takeover by NATO of an ongoing operation and the challenges therein will be discussed.

The article will specifically be orientated towards the Joint Force Air Component (JFAC) and to understand its limitations and possibilities. In the case of OUP, a Combined Force Air Component (CFAC) was established, and the article will refer to this further on. Additionally, OUP will be investigated and summarized to understand how the use of Air Power affected the nature of the conflict and whether NATO conducted a sufficiently structured Air Campaign in order to deal with the rapidly emerging air situation of the Libyan conflict.

Operation Unified Protector

The campaign was initiated by UNSCR 1970 (United Nations Security Council, S/RES/1970 (2011)) and was followed by a NATO-led operation in the Mediterranean commencing on 31 March 2011. OUP brought

forth a coalition of NATO allies and partners, which initiated a no-fly zone and used Air Capabilities to enforce the protection of civilians from attack or the threat of attack.

Initially named Operation Odyssey Dawn (OOD) under a US flag, the shift from that operation to the NATO OUP was not without challenges. Operation HARMATTAN, Operation ELLAMY, Operation MOBILE and OOD were all separate official operations by individual nations. OOD is in this context used as a collective name for the coalition operation.[1]

NATO Organization

'The other side of knowing the enemy is knowing oneself.'[2]

To investigate the NATO organization that dealt with OUP, it would be beneficial to look into the structure of the combat staff, meaning the CFAC and the Combined Air Operations Centre (CAOC).

The command structure of OUP initially consisted of Supreme Headquarters Allied Powers Europe (SHAPE), then the Combined Joint Task Force (CJTF) at Naples subordinate to SHAPE and further subordinate was the Air Command Headquarters Southern Europe in Izmir, Turkey (AC Izmir), who managed the Air Campaign. Effectively, CAOC Poggio Renatico, Italy (CAOC PR), conducted the execution of the Air Operations, subordinate to AC Izmir. Parts of AC Izmir moved to CAOC PR and a CFAC was established with contributions from various nations. The CFAC rapidly assumed control and executed more than 120 sorties daily. The reason for using a CFAC was in relation to the fact that more than one nation from NATO participated in the campaign. Furthermore, the CFAC was planning and conducting Air Operations without a joint aspect. Command and Control (C2) in NATO at that time, was doctrinally clear and precise in respect to establishing an organization (JFAC or CFAC) to manage an operation.

It was expected that NATO would easily transition into the lead of an already ongoing operation and promptly employ assigned forces. The CFAC was undeniably strengthened by both the Izmir staff, who rapidly deployed to CAOC PR, as well as augmentees from contributing nations.

Nevertheless, the start of the NATO management of the air situation seemed to waver. A challenge existed for the air planners to conduct prudent and effective planning during the initial days of OUP.[3] This was primarily due to a lack of appreciation of the varied communications technologies of the participating NATO members and difficulties in integrating their different planning systems. Whether the challenge was nationally grounded in the United States (US) planning system or the planners understanding of the requirements, the situation demonstrated an interoperability problem between some NATO forces and an experience issue with the planners at hand. Additionally, the differences between the US and NATO way of planning had been illustrated clearly at the change-of-command from OOD to OUP when comparing the arrangements from the US perspective. More players would add complexity for the JFC and JFAC in taking over the mission. The evidence of the command change, as well as the organizational move to CAOC PR and lack of supporting and compatible systems at the beginning of OUP showcased the difficulty in inheriting an ongoing operation.[4]

Personnel

Colonel Daniel Baltrusaitis showed that the organizational construct of the CFAC needed to adapt to an agile situation.[5] Additionally, Baltrusaitis suggested that the size of the personnel cadre in CAOC PR was lower at the beginning of OUP, compared to OOD. Participating nations were requested by NATO to augment the CAOC and CFAC with experts and staff officers. Too few augmentees were requested and their initial attachment to the organization was limited to one month's duration. One can argue that the preferred time frame for an augmentee would exceed one month to build the basic knowledge of the position, to understand the typical battle rhythm and to eventually have the capacity to adapt to and overcome changing situations with professional efficiency. NATO took over the operation in late March with the

© E-3A NATO

bulk of augmentees arriving in April and May. After longer tour lengths of 3 months were approved, July and August saw a sudden reduction in augmentees, as they were not readily replenished by the nations. There was no evidence to suggest a reason for the reduction in augmentees, although it could have been based on either a deficiency of personnel with the required skills and/or the lack of motivation for individuals to sign up for a mission during the summer season. Additionally, some nations did not have sufficient personnel attached to the CFAC or the CAOC in permanent positions, leading to difficulty in sustaining a high level of knowledge and understanding of the headquarters battle rhythm when commencing rapid augmentation.[6]

Air Power Challenges in OUP

While the time frame between the OOD and OUP was not protracted, and although the organization in CAOC PR and the CFAC had reacted beforehand and conducted prudent planning, the Community of Shared Interest (all OOD players) had already conducted several flying missions and therefore prearranged the airspace battlefield. Despite this, the battle plan following the OUP takeover was initially ineffective, and the support for moving part of the JFAC into the CAOC was lacking.[7] Why was the battle plan not effective?

Battle Plan

One of the limitations of the plan may have originated with the UNSCR 1973. The resolution called for the end of hostilities and urged the nations (OOD players) to protect civilians and civilian-populated areas. A potentially relevant aspect is that the political determination and strategy of key NATO allies changed in April 2011[8] to a more offensive focus to eliminate the leader of Libya, Muammar Gaddafi. When the political objective was altered so deliberately, the perception of the strategic leaders in NATO could be assumed to shift as well. The challenge for the Air Planners at CAOC PR would be to implement the CFAC Commander's interpretation of the CJTF Commander's intent. Hence, improving the effectiveness of the battle plan.

Dr. Meilinger found that the most important task of the Air Commander (in this case the CFAC Commander) is to select the appropriate strategy for specific conditions.[9] While (communication) technology plays an essential role in revealing masses of information to the

Air Commander, this does not seem to be the driving factor for the difficulties of his battle plan, since the directive should be clear to everybody. According to Dr. Meilinger, a doctrine contributes guidance for action, which facilitates and focuses the Air Commander's (and his/her staff's) work process. The dilemma reveals itself when a doctrine does not operationally fit the strategic changes. This dilemma became evident in OUP when the objective was switched during the campaign.

Agility

Finally, there was a significant lack of support for moving/deploying the organization. To be able to move rapidly and with flexibility, the organization and the leaders would have to be agile. NATO's glossary of terms and definitions, AAP-06, does not contain the word 'agile'. In the Oxford English Dictionary, the adjective's meaning is twofold: 'able to move quickly and easily', and 'able to think and understand quickly'.[10] Studying NATO documents from the time before OUP reveals the following.

NATO was in the post 9/11 era and forming a perspective about the security environment in which NATO would act and react.[11] Based on those security perspectives at the time in 2006, NATO formed guidelines for the nations and the Alliance Capability Requirements. One may argue, that the period from 2006 until the beginning of OUP would be ample time for the nations and NATO to form a training environment and an educational basis for leaders to be able to facilitate the preparedness toward an agile organization. Procurements and military installations typically take more time to be completed. It is therefore more relevant to focus on what may have changed over those five years. The 2010 Strategic Concept is not perceived as relevant in this context, as the strategic focus is usually not adopted by the Alliance immediately after the release of the Concept.

Requirements normally take time to implement in the Alliance. Those requirements on the military level consisted of agility and flexibility in both conceptual and organizational aspects. As NATO states: '… put a premium on improvements in meeting the following capability requirements: the ability to adapt force postures and military responses rapidly and effectively to unforeseen circumstances. This requires, among other things, an effective capability to analyze the environment and anticipate potential requirements, a high level of readiness for our forces, and the necessary flexibility to respond to any sudden shifts in requirements.'[12]

This statement highlights agility as a key requirement. Emphasizing the principle of an agile organization means being prepared and in a position of high readiness is considered vital. The preparation could be completed by a well-trained expeditious group of people ready to assume any tactical Air C2 planning and execution. Reviewing the OUP experience, there was an indication that the CFAC organization was not ready to execute its mission. National augmentees were not sufficiently educated in their specialities. Some nations committed insufficient funding of their military to meet NATO requirements.[13] Funding of NATO (or lack of it) will drive the size and the structure of the organization and will have a significant follow on effect to the training and the readiness of its personnel.

Future Outlook

When focused on NATO's current level of ambition and picking up the trends of the development, one might find the future promising. The JAPCC conference keynote speakers have more than once declared agility of transition, nations' buy-in of technology and personnel as well as flexible and affordable NATO solutions to be the way forward.[14]

Before the handover/takeover from the OOD to the OUP, there was no template to follow. From the agility perspective, the Air C2 community is preparing to strengthen its experience in standing up distributed C2. The transition phase from Baseline Activities and Current Operations (BACO) through crisis up to Maximum Level of effort (MLE) will be effective and swift when a formalized training plan is in place for Air C2 (SME) capacity and responsiveness. It is, again, up to the nations to fulfil the ambition.

© NCI Agency – Creative Media Centre

Conclusions

There were organizational difficulties that made it difficult to execute the Air Operations, although the preceding structure of the organization (OOD) had taken into account a possibility to deploy and rapidly commence operations.

As there were no unplanned fatalities, the mission can only be deemed successful. The lack of the right personnel at the right time and the difficulties of moving a headquarters into another headquarters might always be a limitation. However, the agility requirements need consideration.

'The very nature of contingency operations means that no C2 construct will be fit for purpose in every instance, and regular exercising with a varying number of international partners ensures flexibility of mindset.'[15]

Retrospectively, OUP pushed NATO's conceptual perspective to find a more agile posture. Whether or not that will align perfectly with the current threat of 2019 and beyond, is another question. ●

1. Ehredt, Dave (Lt Cdr), USN, 'Command and Control – Exploring Alternatives', *JAPCC Journal 14*, autumn 2011, accessed 12 Apr. 2017.
2. Warden III, John A., *The Air Campaign*, 2000, accessed 4 Apr. 2017.
3. Chappell, Gareth, 'Operation Unified Protector: No "Swan Song" for NATO', *The Polish Quarterly of International Affairs no. 2*, 2011, accessed 20 Apr. 2017.
4. Meilinger, Phillip S. (Dr.), 'The development of Air power theory.', *Air power leadership, Theory and practice (Defence Studies, RAF)*, 2002, accessed 21 Apr. 2017.
5. Baltrusaitis, Daniel F. (Col) (USAF, PhD), 'Operation Unified Protector: Triumph or warning sign?', *Baltic Security and Defence Review*, 2012, accessed 20 Apr. 2017.
6. Goulter, Christina, 'The British Experience: Operation Ellamy', *RAND (RR676)*, 2015, accessed 5 May 2017.
7. Mueller, Karl P, 'Precision and purpose: Airpower in the Libyan Civil War', *RAND (RR676)*, 2015, accessed 19 Apr. 2017.
8. Ibid. 1.
9. Ibid. 4.
10. Oxford University Press, Concise Oxford English Dictionary, twelfth edition, 2011, accessed 15 May 2017.
11. NATO, 'Comprehensive Political Guidance', 2006, accessed 15 May 2017.
12. Ibid. 11.
13. Ibid. 6.
14. JAPCC conferences 2014–2018, various themes and speakers.
15. Ibid. 4.

Lieutenant Colonel Asger Skov Pilgaard

joined the Royal Danish Air Force in 1995 and graduated from the Royal Danish Defence College in 2010 with a degree in Military Studies. His military training includes both GBAD and an Air Defence operational education, with multiple years of experience equally as operator and commander. Numerous deployments to both Afghanistan and Africa, together with experience as Tactical Director AWACS have given him operational and planning experience that is of great value to the JAPCC and the Alliance.

Space Support in NATO Operations

By Lieutenant Colonel Tim Vasen, DEU A, JAPCC

Space Support Services

NATO, as a technologically advanced Alliance, relies significantly on space-based services. NATO does not own or operate Space systems. Space systems will remain under national control for the foreseeable future. This necessitates a coordinating function to ensure Space support is continual for Alliance military operations. This role is provided by the Space Support Coordination[1] (SpSC) function and is organized into SpSC Elements (SpSCE), which are located in some NATO commands. In 2018 the Policy on Space support in NATO operations[2] was signed and provided NATO, for the first time, with a basic document for the organization of Space support. This was followed by an overarching Space policy released in June 2019.[3] The SpSC function plays a critical role in operations. While Intelligence, Surveillance and Reconnaissance (ISR) as well as Satellite Communications (SATCOM) are usually organized within their respective intelligence and communications channels, the SpSC resides in the current-operations division and covers all other space support concerns. It is possible that military personnel may think of space and approach the SpSC for assistance when it is an Intel or SATCOM problem. In this situation, it is necessary for the SpSC personnel to know the points of contact within intelligence and/or communications, to ensure that support requests are processed appropriately. The important question in situations like this for Joint Commanders is, where and how to obtain Space support to meet their needs.

Conception and Organization

Space support is provided either by national assets of NATO member nations or via commercial services organized and distributed via NATO agencies.[4]

The role of SpSCE is defined in chapter five in the Allied Joint Publication 3.3 (AJP 3.3).[5] The AJP still requires more strategic guidance and currently speaks only to minor space-related subjects while other strategic documents are under development or still missing. To achieve the level of guidance that currently exists in major domains like Air, Land, Sea and Cyber, Space will require advocacy at the highest levels within NATO.

The challenge facing the certification and approval of written guidance within the Space domain is exacerbated by the limited number of Space specialist positions filled by trained personnel. In preparation for a NATO operation there is a requirement within the force generation process for all Space personnel requested to be in place. The limited number of trained Space personnel, both in NATO and within national organizations makes it complicated to fill the requested positions. The same problem affects the staffing of exercises.

The SpSC function at the strategic level is located within Allied Command Operations (ACO) at Supreme Headquarters Allied Powers Europe (SHAPE). Their work includes the development of a peacetime Memorandum of Understanding (MoU), standardization and doctrinal work, as well as having the function of requesting authority in NATO operations (Figure 1). ACO coordinates with National Space capability providers to fulfil requests from subordinate commands.

At the operational level, the SpSCE's are located within the Joint Force Command (JFC) and/or the component command headquarter (HQ) levels. At the Tactical level, SpSCE can be created on an ad hoc basis depending on the nature of the operation. Tactical level refers to NATO assigned Corps level (land forces) like the 1 German/Netherlands Corps (1GNC) or comparable units in the air and naval forces.

The SpSCE's tool to request Space support is via the Space Support Request (SSR) Form, which is a standardized request form and procedure. The request is then transmitted to the strategic level SpSC (ACO) and, if approved, afterwards to the nations or providers. To reduce the requesting time, or for special purposes, it is possible to establish a Direct Liaison Authority (DIRLAUTH) that allows the operational level to directly coordinate with national Space capability providers.

Nevertheless, national Space capability from a specific country to support their national forces, sent under NATO control, is usually provided directly to them. Depending on the nation, this could be a valid support to the NATO operation however, quite frequently, there are classification issues to solve. This is especially so when there are no existing bilateral Space-capability related data-sharing agreements signed between the acting NATO member nations.

Personnel Organization

The SpSC at ACO is permanently staffed with only one Subject Matter Expert (SME), and as such cannot operate around the clock. This can be difficult since it is the approval and requesting authority for SSRs to the NATO member nations. On the operational level the SpSCE at the JFC is permanently staffed with a core element (one or two SMEs) and has to be augmented by up to eight SMEs for an operation. On the component command level there is also a permanently staffed core element of one or two SMEs that will be augmented by up to eight SMEs, depending on the nature and intensity of an operation. The Commander Allied Air Command (AIRCOM) plays a particularly important role as the Air and Space advisor to the Supreme Allied Commander Europe (SACEUR). On the tactical level there are no permanent SpSCE personnel.

The experience taken out of Exercise Trident Juncture 18 (TRJE18) showed that even on the tactical level an organic SpSCE, staffed at least with one Space SME[6] in peacetime is essential. The role of this person is not only to be the Space advisor and planner for the leadership, but also to train and educate the HQ concerning the options and limitations of Space support.

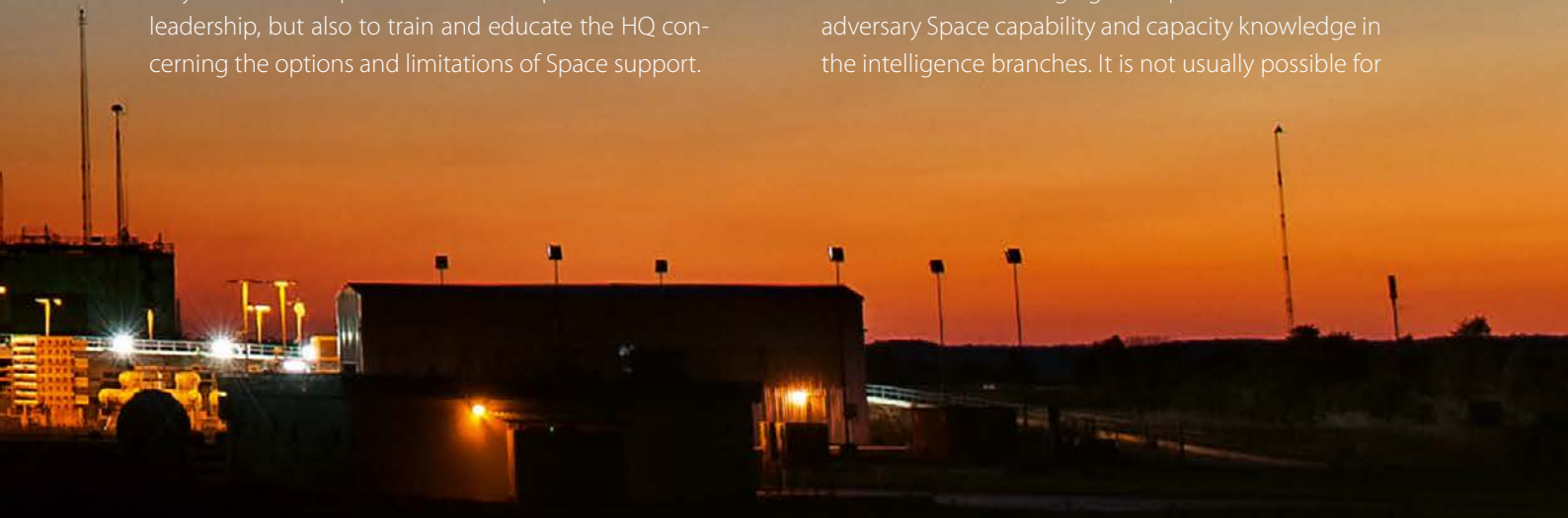
Currently, United States (US) personnel are responsible for the majority of staffing of Space relevant positions within the NATO Command Structure (NCS). Other space-faring nations have personnel in the NCS, but mainly in national positions due to limited numbers.

Training of Personnel

The NATO School in Oberammergau (NSO) offers one Space-related course and is currently developing a second course[7]. The current course is 'Introduction to Space in NATO', which targets Space personnel as well as personnel working with services relying on Space capabilities. The second course will be an advanced course, designed as a continuation from the first and aims to generate more personnel educated to work in a SpSCE. This designated Space Support Coordinator Course is currently scheduled for validation in 2020. There are also several national Space courses that are open to NATO nations, which are distributed within the Discipline Alignment Plan (DAP) for 'Space Support in Operations'.[8]

NATO included Space into major exercises via the Capability Development Circle. The Trident Exercise series[9] has to be mentioned in particular as, according to the NATO structure, the SpSCE are staffed exclusively for the exercise. Based on the exercise requirements it could take a long time to have all positions filled. It is common to educate the personnel from national assignments on NATO specific procedures during exercises, especially the NATO SSR procedure.

Another issue challenging the SpSCEs is the lack of adversary Space capability and capacity knowledge in the intelligence branches. It is not usually possible for



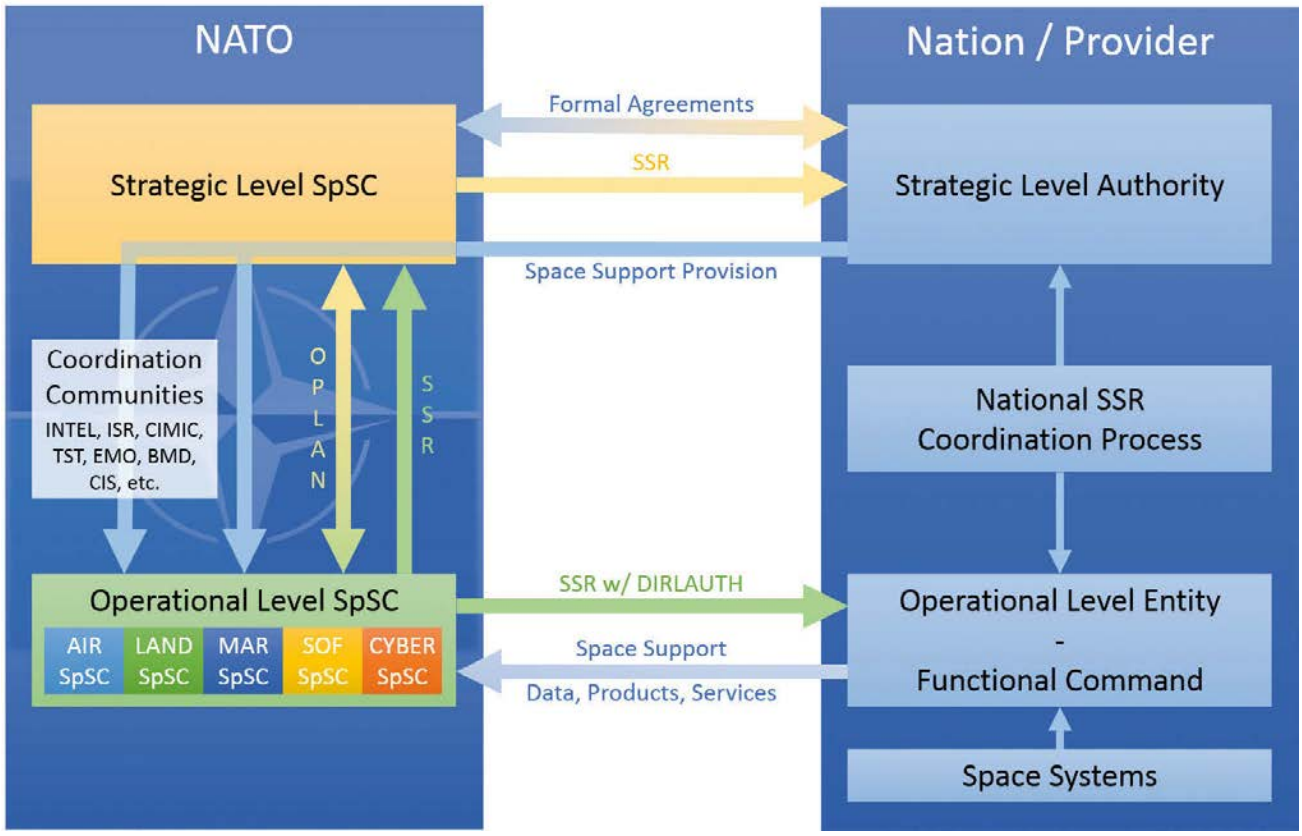


Figure 1: NATO SpSC process.

the intelligence branch to respond to these Commander's information requirements and the intelligence-related questions are regularly transferred to the SpSCE personnel who have a better overview on the topic. During TRJE18 SpSCE took over the Space-intel task permanently because of the major impact on operational planning by the Opposing Force (OPFOR) counter-space actions. Nevertheless, in line with the raised importance of Space and the improvement in the SpSC process, intelligence personnel have to be trained and/or special Space-intel positions have to be established.

Assessments and Findings from TRJE18

A TRJE18 lesson learned for 1GNC was, that it is better to have Space-related personnel embedded within their peacetime structure. For TRJE18 a SpSCE was assigned to the corps HQ to fulfil the Space capability assessment and provide guidance, which included a significant number of briefings and small training exercises. This was necessary because in the 'regular' training and operations cycle of the corps, there was no designated Space support assigned. In the role of Allied Land Command (LANDCOM), in which 1GNC acted in the exercise, it had the coordination role for the first time. In the future, a permanently staffed core element (one SME) should always be available to include Space support in every activity. This will create a greater appreciation and understanding of the Space domain for the leadership and HQ personnel.

Depending on the availability of Space-related personnel within the NCS, they might also be available to train SpSCE that are on call to be assigned to supportable units. The US Army has established SpSCE type function from Division to Army level consisting of four to six personnel located in the operations and planning branches that are augmented when needed.[10]

They support various exercises and operations. These teams might not be available for NATO, but it would also be possible to have them in national bases and allocated to NATO via the force generation process. Realizing this for NATO will be an improvement to the current situation, because the number of Space SMEs will be further increased in the NCS. On the other hand the daily contact between the SpSCE and the rest of the HQ would be still pending.

Conclusions and Recommendations

The increasing complexity of requesting appropriate Space capability support should trigger the need for a stand-alone AJP for Space operations. The process of developing such an AJP will potentially take years and should be initiated as soon as possible. This might provide a refined ability for NATO to react on future Space-related decisions (like recognizing Space as an operational domain).

Based on the lessons learned during the last major NATO exercises, the overall Space organization within the NCS has to be reviewed and extended. Specific attention should be afforded to the SpSC role it requires and additional trained personnel. This education and training could be done either by national or NATO courses. It must be noted that it is more important to ensure positions are filled with trained personnel, than to balance the ratio of nations to the positions.

Space personal, trained through national courses, have also to be familiar with the NATO requirements and procedures. This could be done via courses at the NSO or by participating in a major NATO exercise. Additionally, it would be very helpful if more national Space-related courses could be made available for NATO personnel. From a training perspective, Space support should be included in every NATO exercise and should be a concerted effort of NATO to encourage as many nations as possible to train and educate Space-related personnel. This will highlight the Alliance's forward-leaning approach to collective defence.

Finally, at the tactical level, a core element of an organic SpSCE should be established. A permanently staffed element (minimum one SME) could be assigned to every tactical level HQ. The establishment of a SpSCE pool assigned to NATO could also be another option. A few teams could support NATO exercises and join the tactical level HQs for support. The minimum requirement would be a liaison officer who knows the process. ●

1. NATO Space Handbook Guide to Space support in NATO operations, dated Jul. 2017.
2. MC 0670 Policy on Space Support in NATO Operations, dated 18 May 2018.
3. Annex to PO(2019)0279 (INV), NATO Overarching Space Policy, NATO restricted, dated 24 Jun. 2019.
4. As we focus here on the military portion of the Space support in NATO operations, the support organized by the NATO agencies will not be discussed in detail.
5. NATO AJP 3.3.'Air and Space Operations', NATO restricted, actual version dated Apr. 2016.
6. NATO ACT 'Space capability integration after action report for exercise Trident Juncture 2018 (TRJE18)' dated 4 Feb. 2019.
7. https://www.natoschool.nato.int/Academics/Resident-Courses/Course-Catalogue seen on 22 Feb. 2019.
8. DAP can be found on the NATO website, if not contact HQ SACT JFT Space Support in Operations discipline or JAPCC Space team.
9. See Joint Warfare Centre 'Three Swords Journal 34', Article 'the Continued Evolution of Space Effects and Capabilities within NATO Trident Exercises' published Apr. 2019 for further details.
10. US Army Handbook No. 18-28 'Operating in a Denied, Degraded and Disrupted Space Operational Environment (D3SOE)', http://call.army.mil, dated Jun. 2018.

Lieutenant Colonel Dipl.-Ing. Tim Vasen

began his military career in July 1994 as a conscript. After his officer training he served for several years in commanding and staff positions within the artillery branch, including a deployment to KFOR as company commander of the DEU ISTAR-company. After 2005, he took over positions as an intelligence officer, responsible for IMINT planning and technical assessments, including positions in the office of military studies as a senior analyst for Space systems. From 2013 to 2017 he was part of the German Space Situational Awareness Centre (GSSAC) responsible for Space intelligence. Since October 2017 he serves as a Space SME at the JAPCC, e.g. responsible as OPFOR Space planner in TRJN17, TRJE18 and TRJU19.

© Johan Swanepoel/shutterstock

Congested Outer Space

Increased Deployment of Small Satellite Constellations Could Hamper Military Space Operations

By Arthur Wong, Strategic Development of Forces Division, SHAPE

Introduction

When thinking about satellite construction, most people envision multi-billion dollar projects and satellites which are equal to the size of a city bus. The satellite itself includes expensive equipment as well as propulsion systems, which are capable of manoeuvring to different orbits to avoid collisions with space debris or other assets. This was the case before the 21st century, when spacecraft had to be huge and only national space agencies were capable of funding such programmes, but now we are now entering into a new era where satellites are being built on a much smaller scale and can be constructed in just months.

What are Small Satellites?

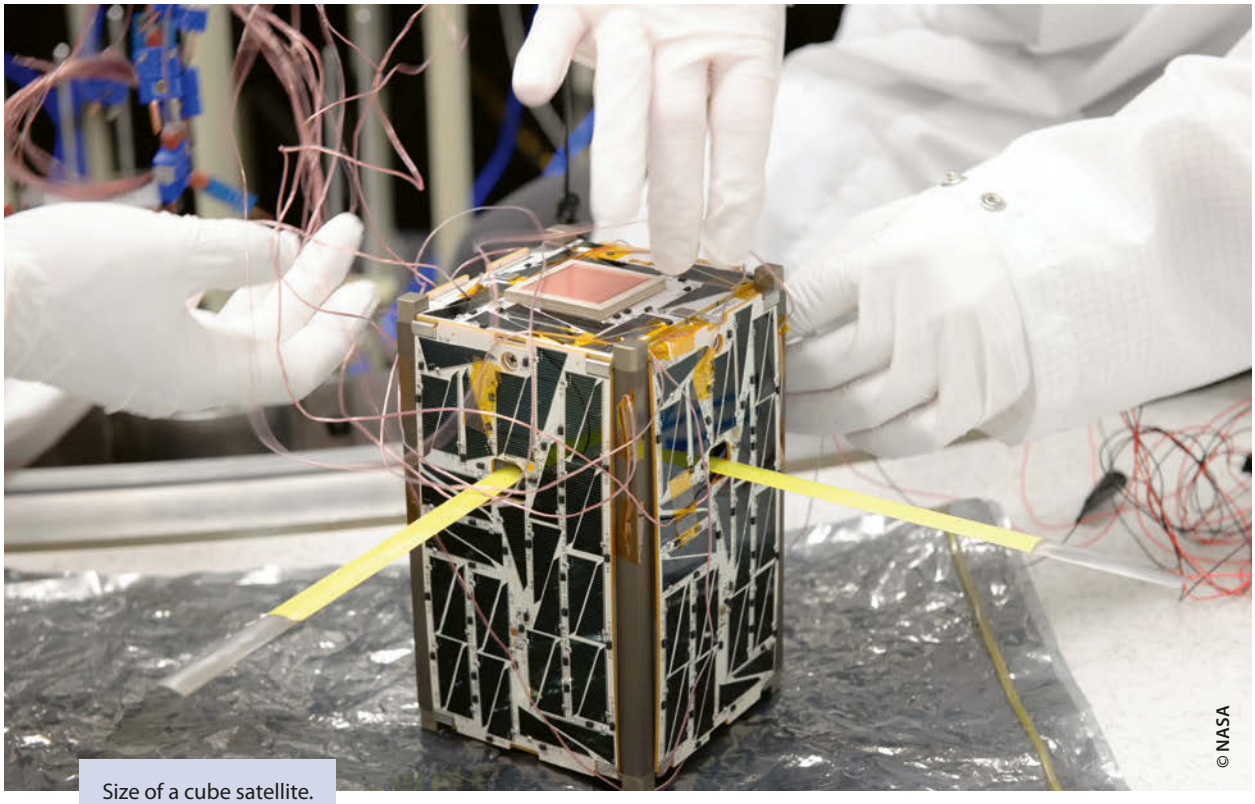
Compared to typical satellites which have ranged in weight from 1,000 kg and up to 6 tonnes, small satellites

are made with both a lower mass and smaller size. While there is no predefined dimensional requirement, the mass is usually less than 500 kg. Small satellites offer an alternative option for space agencies and companies due to the lower launch cost while maintaining similar capabilities to a larger satellite. Among the challenges engineers experience when constructing small satellites are the mass restraints of the spacecraft bus[1]. Such restraints thereby constrain the overall mass of the satellite; further restricting any propulsion systems placed on-board the spacecraft.[2] For this reason, most of the current small satellites projects focus on orbiting in the Low Earth Orbit (LEO) with a few exceptions.[3]

One of the most dramatic changes in the space industry within the last ten years is the transformation from large geosynchronous communication satellites to a constellation of hundreds to thousands of small satellites, linking each other to provide a worldwide communication link in the LEO with a less expensive price tag.

Due to the similarity and functions of each satellite in the constellation, companies and space agencies are able to produce the same item in a factory environment and produce the product at a much higher rate compared to the large satellites, which have to be custom-made to meet the requirements of different missions. While these smaller satellites are expendable and generally will deorbit within a year, they can be purchased and produced in bulk.[4] With a short life expectancy of a year for small satellites at low altitude, it allows companies to upgrade and ensure the equipment on-board the satellites are most up-to-date as they are likely to be replaced within a few years.[5]

The cost of small satellites is also one of the major motivations for companies to adopt this new concept of satellite operations. The lowest production cost of a cube satellite[6] can be as low as USD 50,000. This has attracted small business and universities to develop such assets for space environment assessments



Size of a cube satellite.

and for commercial purposes, which likely contributes to the increasing number of cube satellites in recent years.

The use of small satellites also eliminates the need for engineers to make long-term estimations for on-board equipment that will now be upgraded in the next iteration. In the past, engineers and scientists had to ensure that their equipment would last until the satellite reached its End of Life (EOL), normally anywhere from 10 to 15 years.[7] Malfunctioning instruments would also shorten the length of the mission, causing millions of dollars of losses to companies or space agencies. Small satellites constellations can also provide redundancy and allow engineers to focus on short-term planning. Furthermore, these satellites will also remove the need for redundant payloads, which are used on-board large satellites to increase their survivability, as they can be covered by other identical satellites within the constellations.

Current Plans for Small Satellite Constellations

Since the production of a large number of small satellites in a factory environment will lower the cost of the overall programme, companies such as SpaceX, Amazon and OneWeb have been creating a satellite constellation within the LEO and Medium Earth Orbit (MEO).[8, 9] OneWeb is a new company which plans to create an initial constellation of 648 satellites to provide global satellite internet broadband services. Each satellite weighs approximately 150 kg and will be programmed to operate in 20 different orbital planes at an altitude of 1,200 km.[10] Creating a large constellation within the LEO could mitigate transmission delays and latency due to their closer range to ground stations while allowing users to send and receive data in a timely manner. The first six of the 648 satellites were launched in early 2019 with more launches scheduled to occur throughout this year.

Both SpaceX and Amazon have also announced their intention of creating a separate constellation for internet communication systems. SpaceX satellite constellations, named Starlink, will be the largest constellation ever built when it is completed. The constellations consist of nearly 12,000 satellites in more than 20 different orbital planes.[11] The altitude of Starlink will range between 550 km to 1,150 km. SpaceX aims to have a minimum of 2,200 satellites in the next five years and achieve initial commercial operation by 2020.[12] Amazon's version of constellation, named Kuiper, has also

been seeking approval from the Federal Communications Commission (FCC) to launch more than 3,200 satellites between 590 km to 630 km in the LEO.[13]

Space Debris Threat Increases in the LEO

The usage of cube satellite has provided positive impacts in various fields, ranging from environmental studies to offering worldwide internet access in rural areas through communication constellations. However, the current space environment is becoming congested. Hundreds of satellites have already been scheduled to launch each year before the construction of the constellation programme by OneWeb, SpaceX and Amazon. To further worsen the space debris situation in the LEO, direct-ascent Anti-Satellite Testing (ASAT) was conducted in recent years and more debris will be created through such testing. During the Chinese ASAT in 2007, some debris from the collision was blasted outward away from the Earth, causing a potential threat to satellites above the altitude where the ASAT testing occurred.[14] Nine years after the incident happened, there are still more than 3,000 traceable pieces in orbit.

In 2009, two satellites collided at a speed of 10 km/s at an altitude of 800 km. This was the first time a collision had happened between two satellites. The incident created more than 1,000 pieces of debris larger than 10 cm. Such activity could initiate a chain reaction, creating more collisions from the initial impact. This phenomenon is known as the Kessler Syndrome.[15]

From early 2019, there were approximately 34,000 pieces of debris larger than 10 cm (similar to the size of a cube satellite) and more than 900,000 pieces of debris ranging from one cm to 10 cm in size. Objects that are smaller than one cm in size are expected to be more than 100 million within the LEO.[16] Despite the small size of the space debris, they are travelling at a speed of more than seven km/s. At this speed, tiny objects could harm any large satellite orbiting in the LEO. While satellites can increase their physical hardening to protect the on-board instruments from impact, some satellites cannot be hardened due to the size and dimensional constraints. Furthermore, hardened materials would also increase the overall cost of the satellite.

Constellation in the Making Could Impact Space-Based Military Assets

The previous examples revealed the congestion of the LEO. With companies continuing to launch thousands of small satellites, the chances of a collision in space will continue to increase. This will hinder space-based Intelligence, Surveillance and Reconnaissance (ISR) support to provide valuable information to military operations. A majority of the ISR assets are orbiting in the LEO. NATO relies on space-based assets to assist its operations. Increasing the number of spacecraft in the LEO could raise problems and threats to military assets as well as access to space assets to support operations. If the orbital path of these smaller objects were not tracked by the Space Operation Centre regularly, larger satellites or manned-space stations could be penetrated by the non-propulsion satellites, making them a potential kinetic kill vehicle.

Most satellites within the 600 km region of the LEO are affected by the atmospheric drag, which is helping to bring down some of the obsolete satellites. However, satellites orbiting above 800 km are less likely to be affected by the atmospheric drag, making cube satellites or small satellites without propulsion systems difficult to deorbit once they have reached the EOL.[17, 18] The altitude for some of the OneWeb, Starlink and Kuiper constellations is planned to be above the atmospheric drag region. Despite this, Starlink satellites will have propulsion system for orbital manoeuvre and EOL deorbiting, tracking the full constellation with 12,000 satellites could be challenging for the company and the Combined Space Operations Center (CSpOC).[19] Additionally, there is the possibility of losing contact with satellites before they reach their EOL. Envisat, an 8,210 kg satellite that is currently drifting at an altitude of 785 km, poses a collision threat with other satellites. Envisat was expected to decommission in 2014 but the European Space Agency (ESA) lost contact with the satellite in 2012.[20] If no interaction will be made with the Envisat, it is expected to stay in orbit for the next 150 years.[21]

With the reliance on space-based assets continuing to grow for both civilian and military uses, space will eventually become a more congested environment. The International Space Station (ISS) occasionally has to manoeuvre to different altitudes to avoid debris, which is drifting in the LEO. Debris of up to 1 cm in size could cause critical damage to the ISS. Debris up to 10 cm large could shatter a satellite.[22] Furthermore, nations such as the United States and China are looking into Lunar and Mars exploration in the near future. The constellation surrounding the Earth could pose risks to interplanetary exploration missions. Extensive mission planning will be required to avoid debris collision with the crewed capsule.

The responsibility of CSpOC[23] on Space Situational Awareness (SSA) will steadily increase as we experience more space launches and place more assets in outer space. SSA will provide valuable information on the position and size of the objects in space, whether they are debris or operational satellites. However, the chances of collision from debris will also increase, as there are also limited options for debris removal caused by EOL operation. The international community does have consensus on debris mitigation and finding possible ways of removing space debris, however, implementing these measures will be challenging for many nations.[24] With private companies participating in the construction and launching of the constellation programme, space will continue to become a congested environment faster than ever before. ●

1. Spacecraft bus is the infrastructure of the spacecraft, usually it is used for providing locations for the payload or instruments.
2. Spacecraft bus provides a platform for all subsystems for the satellite such as communications and attitude control.
3. Mars Cube One is one of the examples where small satellites was sent beyond LEO, 'MarCO Makes Space for Small Explorers.' *NASA,* 13 Sep. 2018, www.jpl.nasa.gov/news/news.php?feature=7235.
4. Clark, Stephen. 'NASA: Tracking CubeSats Is Easy, but Many Stay in Orbit Too Long.' *Spaceflight Now,* 30 Jul. 2015, spaceflightnow.com/2015/07/30/nasa-tracking-cubesats-is-easy-but-many-stay-in-orbit-too-long/.
5. Werner, Debra. 'Small Satellites Are at the Center of a Space Industry Transformation.' *SpaceNews.com,* 23 Aug. 2018, spacenews.com/small-satellites-are-at-the-center-of-a-space-industry-transformation/.
6. Size ranging from 10 cm x 10 cm x 10 cm to 10 cm x 10 cm x 30 cm.
7. Werner, Debra. 'How Long Should a Satellite Last: Five Years, Ten Years, 15, 30?' *SpaceNews.com,* 24 May 2018, spacenews.com/how-long-should-a-satellite-last/.
8. Wattles, Jackie. 'SpaceX's New Business Strategy: Rideshares for Small Satellites.' *CNN,* Cable News Network, 5 Aug. 2019, edition.cnn.com/2019/08/05/tech/spacex-smallsat-rideshare/index.html.
9. Greenwood, Matthew. 'New OneWeb Factory Makes Two Satellites A Day.' *Engineering.com,* 6 Aug. 2019, www.engineering.com/AdvancedManufacturing/ArticleID/19424/New-OneWeb-Factory-Makes-Two-Satellites-A-Day.aspx.
10. Amos, Jonathan. 'OneWeb Satellite Operator Eyes Huge Rocket Campaign.' *BBC News,* BBC, 25 Jun. 2015, www.bbc.com/news/science-environment-33268180.
11. Clark, Stephen. 'SpaceX Releases New Details on Starlink Satellite Design.' *Spaceflight Now,* 15 May 2019, spaceflightnow.com/2019/05/15/spacex-releases-new-details-on-starlink-satellite-design/.
12. Ralph, Eric. 'SpaceX's First Dedicated Starlink Launch Announced as Mass Production Begins.' *TESLARATI,* 30 Apr. 2019, www.teslarati.com/spacex-starlink-first-launch-date/.
13. Dvorsky, George. 'Keeping Up With SpaceX, Amazon Seeks to Launch More Than 3,200 Internet Satellites.' *Gizmodo,* 9 Jul. 2019, gizmodo.com/keeping-up-with-spacex-amazon-seeks-to-launch-more-tha-1836212485.
14. Shachtman, Noah. 'How China Loses the Coming Space War (Pt. 1).' *Wired,* 1 Oct. 2008, www.wired.com/2008/01/inside-the-chin/.
15. LaVone, Michelle. 'The Kessler Syndrome Explained.' *Space Safety Magazine,* www.spacesafetymagazine.com/space-debris/kessler-syndrome/.
16. 'Space Debris by the Numbers.' Edited by ESA, *European Space Agency,* Jan. 2019, m.esa.int/Our_Activities/Space_Safety/Space_Debris/Space_debris_by_the_numbers.
17. *ORBITAL DEBRIS PROGRAM OFFICE,* NASA, orbitaldebris.jsc.nasa.gov/faq/#.
18. 'Satellite Drag.' *Satellite Drag | NOAA / NWS Space Weather Prediction Center,* www.swpc.noaa.gov/impacts/satellite-drag.
19. Henry, Caleb. 'Musk Says Starlink "Economically Viable" with around 1,000 Satellites.' *SpaceNews.com,* 16 May 2019, spacenews.com/musk-says-starlink-economically-viable-with-around-1000-satellites/.
20. Envisat was originally expected to reach EOL in 2007, but was extended to 2014 after its initial planned mission lifetime.
21. Gini, Andrea. 'Don Kessler on Envisat and the Kessler Syndrome.' *Space Safety Magazine,* 15 Sep. 2014, www.spacesafetymagazine.com/space-debris/kessler-syndrome/don-kessler-envisat-kessler-syndrome/.
22. Plaugic, Lizzie. 'This Is What Happens When a Tiny Piece of Flying Space Debris Hits the ISS.' *The Verge,* 12 May 2016, www.theverge.com/2016/5/12/11664668/iss-window-chip-space-debris-tim-peake.
23. CSpOC provides a focal point for the operational employment of worldwide joint space forces, and enable Joint Functional Component Command Space commander to integrate space power into global military operations.
24. 'International Consensus on Debris Threat.' *European Space Agency,* 21 Apr. 2017, www.esa.int/Our_Activities/Space_Safety/Space_Debris/International_consensus_on_debris_threat.

Arthur Wong

is working as a Space Subject Matter Expert at SHAPE, within the Strategic Development of Forces Division. He studied Space Engineering at York University in Canada. Current tasks at SHAPE include coordinating space support for NATO operations and incorporate space threat activities to NATO exercises. Prior to working at SHAPE he has worked at NATO HQ, within the Defence Investment Division on interoperability for NATO's multinational battlegroups.

New Space

Advantage or Threat for the Military?

By Lieutenant Colonel Heiner Grest, DEU AF, JAPCC

Introduction

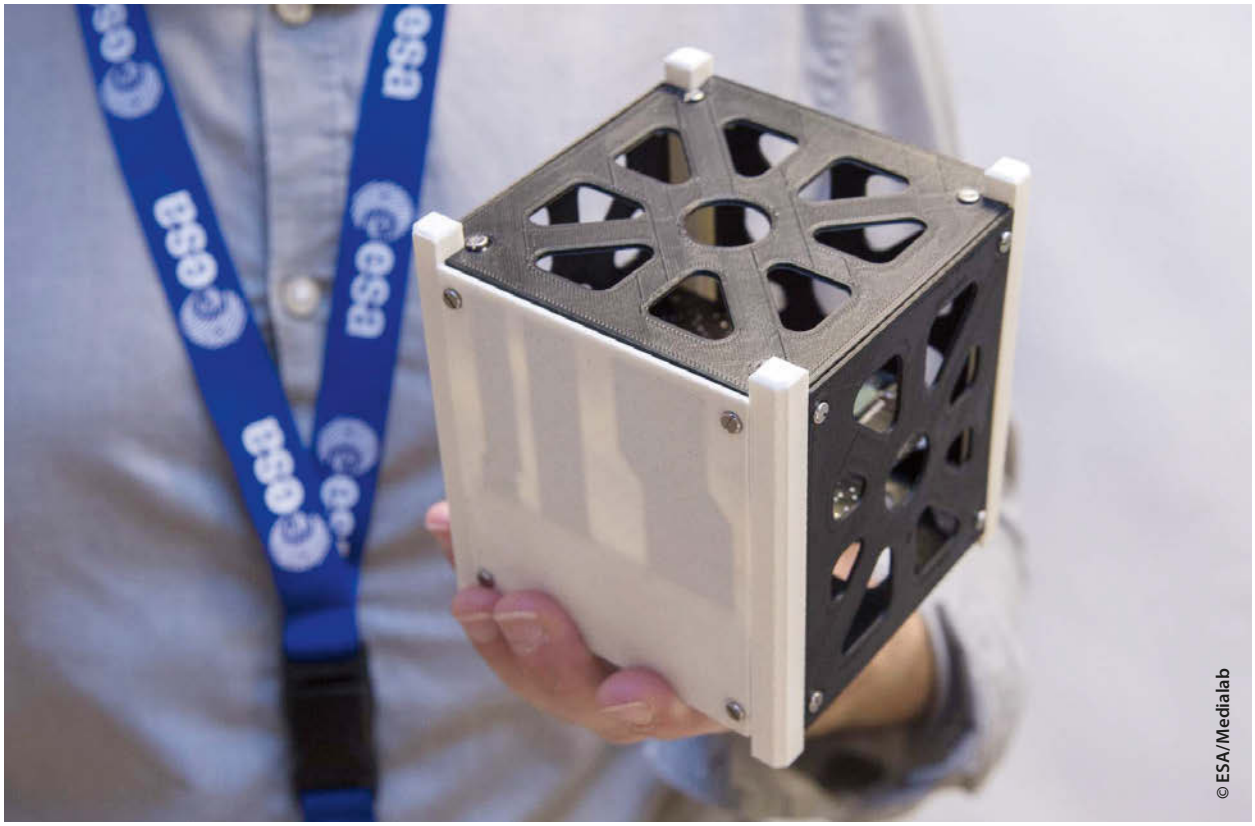
The importance of Space-based capabilities in today's modern world and especially in technologically advanced armed forces is beyond dispute. Satellite communications, precise positioning and navigation, time synchronization as well as Space-based Intelligence, Surveillance and Reconnaissance (ISR) bring inestimable advantages to the modern warfighter. The Military played a leading role in developing Space capabilities and was the primary user of Space-based services during the early years of the Space era.

However, today, the preponderance of use has shifted, civil organizations and companies are the prevalent actors. This trend was labelled 'New Space' and seems to be the buzzword in current Space literature.

This article will shed light on the development of this trend, represent its characteristics and explain the importance of 'New Space' for the military, particularly in light of the likely future development.

Development and Attributes

The first actors in Space were governmental organizations, especially the military (e.g. German A4 Rocket development, first astronauts and cosmonauts) and for decades the military was driving the technological developments and the leading actor in the new frontier.



© ESA/Medialab

This era, named 'Old Space' or 'Traditional Space', was characterized by tailor-made solutions with a unique satellite design for long-lasting missions (10–20 years). The heavyweight of the satellites was usually 150 kilogram (kg) to several tons. Long-lasting project development times of more than three years, extensive testing of the components, as well as significant launch costs were key characteristics. The activities depended on governmental control as well as public budget with only a few prominent aerospace firms vying for government contracts. This was a bureaucratic top-down process with a limited number of competitors.

In the early 2000s, a paradigm shift for Space took place. Private actors started to invest heavily in the United States (US) Space sector. Ten years later, major changes occurred worldwide, especially in the two main areas – Space economy and Space technology.

Private companies discover Space as a new investing opportunity at their own risk, looking to provide specific Space-based services that have the economic potential to generate substantial financial returns. Modern forms of financing (Crowd Funding, Venture Capital Investments) and business models have been increasingly applied. The headline 'Space, the final Economic Frontier' is an accurate characterization of the shifting development direction of Space.[1]

The trend to smaller satellites (mini, micro, nano, pico, femto[2]) is the most significant aspect of the technological area. A forecast of expected launches into the Low Earth Orbit (LEO)[3] until 2030 shows, that 68 % will be small satellites weighing one to 15 kg and an additional 25 % weighing 16 to 75 kg.[4] Standardized interfaces and form factors, as well as the use of industry, certified Commercial Off-The-Shelf (COTS) components and pre-qualified parts and systems are common characteristics. Rapid design times of less than one year, paired with shorter mission lifetimes of up to seven years and quick-launch capabilities (newly specified spaceports like 'Spaceport America', 'Mojave Air and Space Port', 'Mid-Atlantic Regional Spaceport') at affordable cost are additional attributes of 'New Space'.

Short delivery times, serial production, a high degree of standardization and lower prices are the results of the previously mentioned changes in Space economy

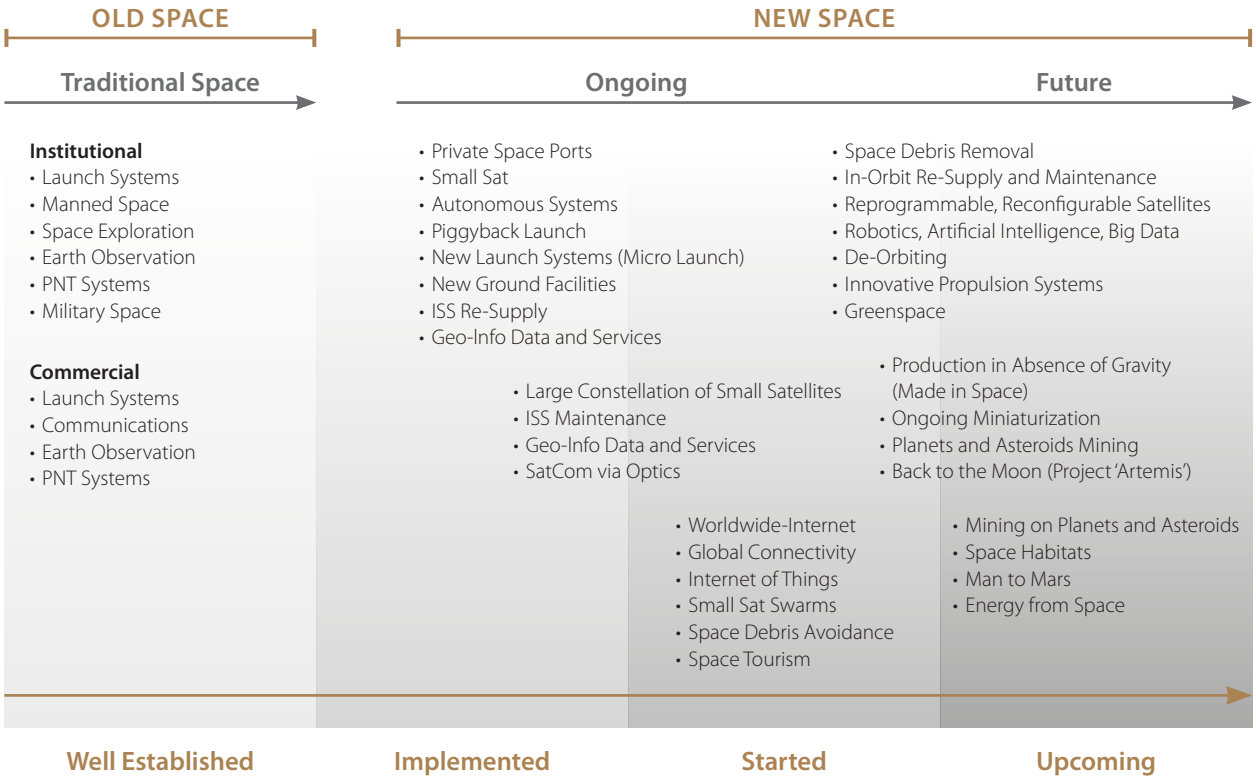


Figure 1: Space Business Segments (non-exhaustive).

and Space technology areas. Access to Space is easier for an increasing number of countries, organizations and companies. This entails a massive expansion of Space protagonists. More actors from nations and commercial organizations mean more opportunities and more competition. This leads to a new 'Space Race' for scientific and technological advantages as well as social and economic challenges.

These 'big steps' of improvements in Space-based services are a consequence of shorter and quicker decision processes in civilian companies compared to governmental and military organizations. Additionally 'New Space', 'Industry 4.0' and in particular the Information Technology (IT)-sector (Smart Manufacturing, Industrial Internet of Things, or Cloud Computing) are heavily interacted and dependent on each other.

'Old Space' was mainly a research area. 'New Space' is characterized by a technological approach of innovation and products, as well as new business models with a high degree of commercialization and decentralization. It is a highly dynamic and visionary process that opens up new commercial areas beyond the traditional aerospace sector. Public funding is still a significant source for large Space programmes, but in the area of small satellites, private funding is rapidly growing.

Benefits and Risks

'The dominance of the commercial sector in technological development is an on-going major trend, as well as their growing in areas where states used to dominate.'[5]

In 2017 Global Space activity accounted for $ 383.51 billion and the total revenues from the commercial Space sector were 80.1 % of the global economic activity in Space, or $ 307.32 billion, including private and public activities.[6]

The commercialization of Space – and of its prerequisite, the commercialization of Science – allows new applications and are a precondition for future new disruptive technologies[7] on Earth. This ongoing development means more extensive benefits as well as higher risks.

The main benefit is a better cost-value ratio. New satellites are cheaper, and a shorter life will be compensated by shorter replacement periods, to ensure that satellites with state-of-the-art performance are on orbit at all times. As a result, small satellite clusters will replace a substantial number of large satellites.

Another benefit is intensive networking with the information and communication business, which represents the main driver for Space technology as well as an intensive cooperation with government, industry and academia.

Risks are high on initial investments for complex products, high general business risks, open questions in liability and insurance obligations. Especially in their starting phase New Space companies need a special degree of patronage of government and anchor costumers.

Legal issues are ongoing obstacles in the commercialization of Space. There is an existing clear framework around Space activities; however, questions about commercial Space aspects remain. Some nations adopted new policies to regulate their national commercial activities in Space; e.g. US 'Space Act 2015'[8], or Luxembourg's law for extraction of resources on other celestial bodies and asteroids.[9] To which extent this is in line with international Space law and treaties needs further investigation by Space law experts. Generally speaking, the current development for further use of Space by state and private users can appear as not only an urgent but also an intractable problem. Many of today's Space activities are not regulated in existing international and national Space laws and treaties. This lack of clear rules and process is driving up uncertainties and risks for commercially oriented companies, and a greater regulatory clarity is urgently needed otherwise they will operate in a 'grey zone', which can lead to incalculable financial risks.

The United Nations are developing a Space Agenda with specific consideration of economic aspects.[10] As a consequence, experiences out of today's commercial activities will have a major influence on future Space law.

Military Challenges and Implications

Two main aspects of 'New Space' are essential for the military: the unrestricted usage of own national Space assets and the guarantee of safety and security in Space.

For their usage of Space, militaries have specific requirements and standards for their equipment. These differ somewhat from civilian requirements. In this view, the advantage of 'New Space' – buying developed and available products on the market – is not necessarily an advantage for the military. The possibility to use commercial equipment would reduce investment cost and shorten the procurement lead time. These satellites are mass products, they are usually cheaper, more readily available and successfully tested, however, not necessarily optimized for military needs. Slight individual adaptations concerning specific military requirements are still possible, but increase the cost and the time to be operationally ready.

There are, therefore, some disadvantages to seeking existing commercial products for military use. Only minimal adaptations are possible, and the market offers only a few or in some cases no suppliers for individual military products. Specific military requirements (military-grade encryption of data/data links, reliability, availability, access) require extensive customization at significant cost or new developments. Vulnerability and availability under combat conditions certainly present challenges.

Otherwise, if using a mass-produced satellite, the military is no longer the sole user. Other users of this product-line are eventually non-military or non-NATO states, maybe even a potential adversary. This raises the fundamental question for defining specific components or applications with individual military requirements and on the other side fields where COTS products may be sufficient. A high degree of dependence on commercial offers, if they don't pursue activities with respect to military requirements could lead to loss of specific knowledge and competence.

In general, NATO has an open-minded approach to these challenges. As an example, NATO's Joint Air Power Strategy states 'capabilities for reconnaissance

and surveillance must be tailored and take advantage of cost-effective technologies'.[11] It also includes 'Acquisition of commercially developed capabilities, especially networked capabilities, must occur in a flexible and timely manner and balance potential cost savings against the risks of supply chain cyber intrusion'.[12] In addition, a NATO Science and Technology Organisation (STO) research is titled 'Opportunities/Implications of large scale Commercial Small Satellites Constellations to NATO Operations'.[13]

Guaranteeing safety and security in Space is increasingly challenging for any Space Surveillance and Tracking (SST) capability. Today millions of pieces of Space debris, including ~20,000 parts larger than ten cm in diameter are orbiting the Earth and creating a high risk for collision. More actors in Space means more objects in Space, leading to more Space debris (despite Space-debris mitigation measures) with a higher risk for collisions and the need for more collision avoidance manoeuvres. This results in less operational time for each individual satellite and therefore a higher rate for replacement. This requires a highly sophisticated SST capability with modern sensors, well-equipped operation centres and well trained personal. SST, Recognized Space Picture (RSP) and in future, the Space Traffic Management (STM) are typical (but not exclusive) military tasks, and the requirements will rise at the ratio of more activities and actors in Space.

The reduction of the Research and Development budget in defence spending combined with increasing commercial innovation led to an overreliance on commercially available solutions, therefore, the loss of defence-focussed Research and Development skills may increase security risks.[14]

There seems to be no limit in theoretical thinking: latest and highly surprising is a US Air Force idea for utilizing commercial satellites for nuclear command and control.[15] This idea emphasizes the need for resilience and US Air Force Chief of Staff General Goldfein stated '… the rapid and exciting expansion of commercial Space and bringing low-earth orbit capabilities that will allow us to have the resilient pathways to communicate'.[16]

'New Space' will force us to contend with great competitive dynamics, resulting in frequency-management due to mega-constellations and high numbers of planned new satellites.

Additional challenges, connected to 'New Space', are resurgent Russian and emergent Chinese Space activities with fast development and deployment. This might lead to a new strategic competition or a 'New Space race'.

As a first answer to these challenges, NATO published the 'Overarching Space Policy' in June 2019, emphasizing Space is essential to coherent Alliance deterrence and defence.[17] This initial step could be the starting point of an unrestricted adoption of Space in NATO's planning, operations as well as organization. The next step could be NATO's recognition of Space as an 'operational domain'.

Conclusion

Fifty years after Apollo 11 astronauts first walked on the moon, the world is in a 'New Space' era. Outer Space, a domain once reserved for the great powers, is democratizing. New spacefaring nations and private corporations are entering the new frontier and taking advantage of new technologies and lower financial barriers. Previous Space actors no longer have the monopoly for access and operations in Space. New actors in the form of profit-oriented companies are seeking to conquer Space. Creating new business fields to make money and new funding opportunities is the economic trend. New technologies and production facilities open up new spin-off possibilities and therefore are an engine for transfer of technology. The driver for further developments in Space is no longer governmental organizations, but private companies. More companies demand more competition, this generates more variety, and in the end more changes and risks. Today we are at the beginning of new development in spacefaring – the impact of which cannot be predicted.

As NATO depends on support from Space assets, they have to have a close look at these trends and remain engaged. NATO must be a driver for capability

Cold War Space Power Model 'Technocracy'	21st Century Space Power Model 'Netocracy'
National	International
Secret	Transparent
Military-led	Commercially-led
Independent	Networked
Few, large platforms (vulnerable)	Many, small platforms (resilient)
Slow, top-down innovation	Rapid, bottom-up innovation

Figure 2: Comparison of space power models according to J. C. Moltz[19].

development in Space and for alternatives like High Altitude Platforms (Near Space), use of commercial civilian satellites for military needs (e.g., US Space-based Kill Assessment)[18], and launch-on-demand. New forms of organizational cooperation with private companies in all areas of interest have to be investigated.

Increasing activities in Space require more and better coordination of orbits than current Space Situational Awareness and postulate a RSP as well as means for Space Traffic Control. Legal and regulatory developments must keep up with the pace of technological innovation. While regulations for the airspace are under national jurisdiction, common agreed UN regulations in Space are necessary to avoid risks and conflicts.

It has been a postulation for the military at all times, to be at the top of technology. For the area of New Space, the door for close cooperation must be opened. A strong networking which keeps more than one eye on ongoing technological developments of private actors and adaptation of their solutions for military needs might be very fruitful. Proven commercial solutions can offer additional chances for the military to optimize for space-specific challenges in financial, organizational and technological aspects. ●

1. Weinzierl, Matthew: Space, the final economic frontier, in: Journal of Economics Perspectives, Vol. 32, Number 2, Spring 2018, p. 173–192.
2. Small satellites, miniaturized satellites, or small-sats, are satellites of low mass and size, usually under 500 kg (1,100 lb).
3. Low Earth Orbit, typically orbits from 200 to 2000 km.
4. http://interactive.satellitetoday.com/via/april-2019/space-industry-fast-forward/, assessed 15 Jul. 2019.
5. NATO Strategic Foresight Analysis, 2017 Report, p. 52 f.
6. ESPI report 65 'Space Policies, Issues and Trends in 2017–2018', published by European Space Policy Institute, Vienna 2018, p. 14.
7. Disruptive technologies are fundamentally advanced innovations that replace or completely remove an existing technology, product or service from the market.
8. US Space Act 2015, https://en.wikipedia.org/wiki/Commercial_Space_Launch_Competitiveness_Act_of_2015, assessed 19 Jul. 2019.
9. https://spacenews.com/luxembourg-adopts-space-resources-law, assessed 16 Jul. 2019.
10. https://unchronicle.un.org/article/space-technology-and-implementation-2030-agenda, assessed 18 Jul. 2019
11. NATO Joint Air Power Strategy, 20 Jun. 2018, No. 47.
12. NATO Joint Air Power Strategy, 20 Jun. 2018, No. 51.
13. NATO STO SCI-308, Nov. 2017–Feb. 2019.
14. These risks may result from non-compliance with specific military needs, but also from the general access of other parties to these commercial products; see: NATO Strategic Foresight Analysis, 2017 Report, p. 8.
15. https://www.nationaldefensemagazine.org/articles/2019/6/26/air-force-wants-to-utilize-commercial-satellites-for-nuclear-command-control, assessed 18 Jul. 2019.
16. Ibid. 15.
17. NATO Overarching Space Policy (NATO Restricted), published, 26. Jun. 2019.
18. https://spacenews.com/mda-kill-assessment-sensors-would-be-commercially-hosted/, assessed 22 Jul. 2019.
19. Moltz, James Clay, The changing dynamics of Twenty-First-Century space power, Online Resource: https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-13_Issue-1/Moltz.pdf, p. 78, assessed on 3 Sep. 2019.

Lieutenant Colonel Heiner Grest (DEU AF)

is currently serving in the C4ISR+S Branch as a Space SME. In 1982 he began his military career as a conscript. In previous appointments he has been working in various command and staff positions in the area of Surface-Based Air and Missile Defence as well as in different national staff positions. He was deployed to the NATO mission in Afghanistan at ISAF HQ. Lieutenant Colonel Grest holds a diploma in business administration from the Bundeswehr University Hamburg.

Soldiers: © US Air Force, Master Sgt. Renae Pittman; Drones: © aerogondo2/shutterstock; Path: © Pexels/pixabay; UGV: © GrantTurnbull/shutterstock; City: © denisgo/shutterstock; Robot: © Pavel Chagochkin/shutterstock; Satellites: © ESA

Joint Personnel Recovery 2040

A Study in Search of a Global Perspective

By Lieutenant Commander Tommaso Barone, ITA N, JAPCC

Introduction

During the last decade, the geopolitical environment has changed significantly, and it is expected to change even more quickly in the years to come. Nations and military organizations have been forced to address, on a nearly daily basis, how the rapidly changing global environment might affect their own strategic vision and the Future Operational Environment (FOE) is subject to the instabilities associated with global interactions. The European Environmental Agency assessment, completed in 2014[1], identifies five distinct global megatrends as FOE-influencing factors: political, economic, social, technological, and environmental. Within these trends, the FOE is expected to be disproportionately affected by technological and environmental sectors, but will also be influenced to a lesser degree by the political, social and human sectors. Economic trends might have corresponding consequences, directly or indirectly, for the developments and requirements of future systems and capabilities, such as Artificial Intelligence (AI), robotics, engineering, communications, human performance and leadership. As Joint Personnel Recovery (JPR) activities occur across the full spectrum of operational environments, a well-informed under-

standing of the current 'big picture' about the JPR world, as well as elements likely to arise in the imminent future is undoubtedly an indispensable condition for success.

Problem

One of the most imperative responsibilities of an operational Joint Force Commander (JFC) is the protection of his most valuable asset: the people in the Joint Force. As stated in the Multinational Capability Development Campaign (MCDC) 2017–18 project, 'In order to be most productive and effective, people who are sent into harm's way must have confidence that if something bad occurs, their unit, organization or government will do the utmost to find and bring them safely home.'[2]

Contrary to what one might expect, and according to numerous observations generated by the JPR community in various ways, it seems JPR operations are not always given, in general, enough consideration during initial planning phases. However, should personnel become isolated during contingency or other operations, then such consideration quickly becomes imperative for a Commander. A person or a team that becomes isolated initially presents as a tactical problem, but as history has demonstrated, their isolation can quickly develop into a scenario that might have strategic effects on a nation's and/or coalition's operational ability and more importantly, on its resolve to continue with the operation.

The 2011 Joint Air Power Competence Centre (JAPCC) White Paper 'Personnel Recovery, That Others May Live to Return With Honour – A Primer'[3] provides an overview of the history and conceptual developments of Personnel Recovery (PR). Over the last few decades high profile events involving isolated personnel or hostages have had a significant impact on opinions of the general public. Some of these situations caused political embarrassment and significantly altered or ceased military operations due to sensitivities tied to public perception. Because of the expanse and accessibility of the internet and social media, news travels around the globe much faster now than in the pre-internet era. People receive more detailed information faster and become more and more aware of rescue cases.

Working Environment

This begs the question, 'Is the global JPR community well-positioned to successfully prepare and execute multinational/coalition JPR over the next two decades?'

The MCDC 2019–20 project, entitled 'Joint Personnel Recovery 2040' should help answer this question.

The MCDC is a United States Joint Staff, J7-led programme consisting of 23 partner nations and organizations focused on developing non-material solutions to capability gaps for Joint, Multinational and Coalition Operations to meet present and future needs of the United States and mission partners. The previous JPR-related project in 2017–18 was aimed at improving capability, capacity, and interoperability of JPR in combined operations planning and execution and delivered a first of its kind product, incorporating research, analysis and expertise to construct a nation-agnostic global JPR guidebook.

The MCDC 2019–20 project is the perfect mechanism to formally launch a unique partnership between the US Joint Personnel Recovery Agency (JPRA) and the JAPCC. The JPRA is the designated project lead and engaged the JAPCC to support, as 'de-facto' co-lead, considering the JAPCC an excellent source of relevant expertise.

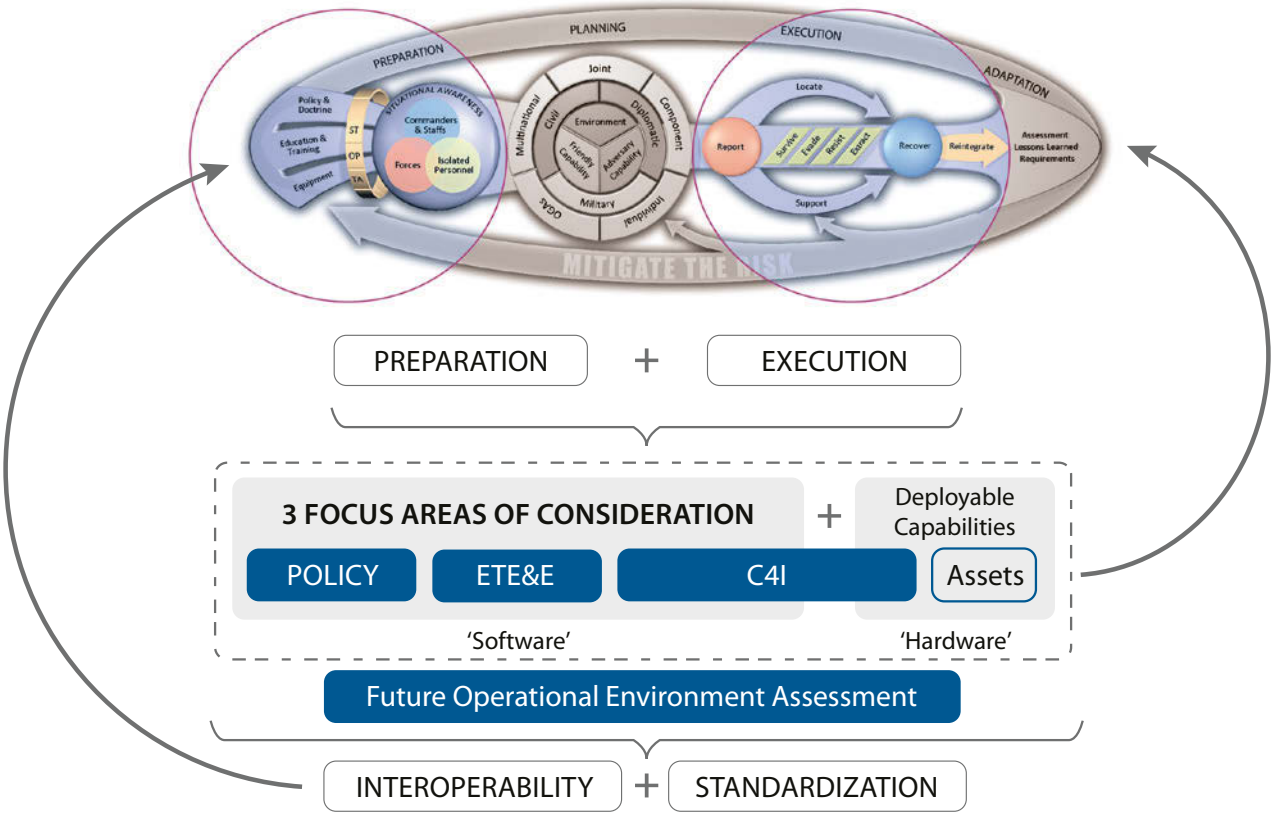
During two Cycle Planning Workshops (CPWS), the composition and overall concept plan of the project was set. Again, 21 additional motivated nations and organizations committed to supporting the project with varying levels of participation, whether as contributors, observers, supporters or co-leads.

Work

The team focused their attention on defining the purpose of the initiative, starting with the building blocks of a basic quad chart to identify a coordinated problem statement and, ensure a common vision/end state, then determined the deliverable of the final project plan, as well as the operational relevance of the project. The primary purpose at this stage of the workshops was to provide a common operational picture on JPR, its future challenges and possible shortfalls and to achieve adequate solutions and final recommendations to improve the JPR capability. The problem statement for this project may be expressed as:

The global Joint Personnel Recovery (JPR) community, comprised of Allied & Partner Nations, multinational organizations for collective security and Diplomatic, Interagency and Civil JPR stakeholders, requires an assessment of Collective Capability, Capacity, Interoperability and Commitment (CCIC)[4] to improve and ensure the effectiveness of the full JPR System now and in evolving operational environments over the next two decades.

The team, established with a common methodology/approach, including fact-finding research and inductive analysis, will be driven by the overall question of 'What is required to ensure the global JPR System will be effective in 2040?' The project will design and conduct a group of related studies that assess the current state of the global JPR system and propose how changes might impact coalition military, political/diplomatic and civil policies, doctrine and resource commitments to JPR. This process will help remedy significant knowledge gaps and inform the decision-making of Allies, Partner Nations and Multinational organizations, providing recommendations to prepare and conduct JPR operations over the next two decades. An analysis of the existing JPR/PR literature will be carried out (Lesson Identified/Lesson Learned from exercises, Case Studies on PR and JPR). Specific personalized questionnaires and interviews will be created and submitted to countries that want to voluntarily contribute to the study. New 'Case Studies' might be conducted in Colombia and Mali, along the Pacific Coast and in North-Eastern Europe to examine various threats, operational domains, challenges and trends. Wargaming will also be used to test and critically analyse various assessments, conclusions and recommendations. The JPR Project will incorporate observations from international JPR multilateral exercises. Finally, emerging threats, technological development, demographic and geopolitical trends will be analysed to determine possible impacts on the future capabilities of JPR.



Joint Publication 3-50, Personnel Recovery, 2 October 2015. © US Joint Personnel Recovery Agency, Graphic by Lt Col Georg Stauch, DEU Army

It was decided to use three combined focus areas by which capability and interoperability may be assessed:

1. Policy, Doctrine and Standardization;
2. Education, Exercises, Training and Evaluation;
3. Deployable Command and Control or Command, Control, Communication, Computers and Information (C4I).

Each of these capability areas will be addressed as a distinct research effort, or Line of Inquiry (LOI), led by a designated lead within the project team and framed within the context of a fourth LOI, the assessment of the FOE for JPR in (and leading up to) 2040.

The United Kingdom is leading the research team for the FOE LOI, joined by Canada, Australia, the Netherlands and the European Personnel Recovery Centre (EPRC).

Germany is leading the research and solution development team for Policy, Doctrine and Standardization and the C4I LOI, joined by Denmark, Sweden and Poland.

Italy is in the lead for the research and solution development team for the Education, Training, Exercise and Evaluation LOI, joined by Spain, Hungary, Romania and the EPRC.

Other project members (including NATO ACT, the JAPCC, the European Union/European Defense Agency, the European Personnel Recovery Center and JPRA) will participate on an ad hoc basis, contributing to and co-ordinating with each of the LOI teams.

Furthermore, this study will focus primarily on the Preparation and Execution Phases of the JPR System. Preparation is where decisions and resultant activities for all three of the combined assessment criteria are undertaken, and it is in the Execution Phase where the effectiveness of those decisions and activities may be evaluated (however, this does not mean that we will ignore issues we may find occurring in the Planning and Adaptation phases).

The graphic above illustrates the key elements of the methodology:

Two out of four planned project Working Sessions (WS) have been held to date, and substantial progress was made on both occasions. During the first WS, the team was able to assess and finalize research assignments for all LOIs. Most importantly it accomplished a primary workshop objective of confirming the project 'roadmap' activities and schedules, as well as cross

levelling of the information by all LOI subgroups, and approving the way ahead for the teams. The second WS was the corroboration of the previous WS effort, and built off the initial research of the teams, while proposing various PR related scenarios that may be tested in future wargames, which will be conducted by the project teams.

The purpose of the wargames will be to define which capabilities will best ensure timely, effective coalition personnel recovery in each of these scenarios within the future operating environment. Put another way, it will determine which capabilities will best address the collective gaps and shortfalls identified during our research. The current LOI teams will be broken up into scenario-based teams each of which would develop a PR event and corresponding mission, driven by defined 'research questions' focused on the preparation and employment of select capabilities. The research questions or hypotheses may also be potential capability development recommendations which could be tested via the game.

Conclusion

The protection of the force is a basic military principle upon which the JPR concept is founded. Despite near-continuous cooperation among coalition partners across the full spectrum of JPR, there exists no current single study that prioritizes all of the JPR CCIC gaps and seams among coalition partners. The JPR 2040 project is most probably the first study involving representatives from across the global JPR community, which attempts to assess this lack of priorities, approaching the problem from different perspectives. This kind of approach aims to deliver recommendations with which nations and organizations can develop a number of interoperable capabilities.

The project should not be limited to military entities. The intent is to reach out to diplomatic (Departments of State, Foreign Ministries, United Nations), civil (Non-Governmental and Inter-Governmental Organizations), as well as potential commercial stakeholders. Anyone operating in a future environment is at risk of becoming an Isolated Person (ISOP).

The two remaining Project Working Sessions will be hosted by Spain in March 2020 and by the JAPCC in September 2020. The publication and distribution of the project are expected by the end of December 2020.

The willingness of the project team might be summarized in a quote by a classical Greek (Athenian) philosopher:

'I cannot teach anybody anything,
I can only make them think.'
Socrates

More to follow!

1. European Environment Agency, 2014 assessment of Global megatrends – an update: www.europe.eu
2. MCDC 'Joint Personnel Recovery' – a guidebook for improving Multi-National capability (Dec. 2018).
3. JAPCC White Paper 'Personnel Recovery, That Others May Live to Return With Honour – A Primer' (2011).
4. Capability is defined as the ability to perform a function; Capacity is defined as the amount of a given capability; Interoperability is the ability to perform a function effectively with one or more partners and Commitment is the willingness to employ capability at some capacity at a specified time.

Lieutenant Commander Tommaso Barone

joined the Italian Navy in 1997. He was trained by the US Navy and qualified as Naval Aviator in 2003. He participated in all major operations including 'Active Endeavour', 'Leonte', 'Atalanta' and 'Isaf'. In 2010 he deployed on ITS CVH 'Cavour' for the Operation 'White Crane' in support of the population of Haiti. In 2015 he was stationed in Antarctica as Operational Director of the XXXI 'Italian Antarctic Expedition'. He is an instructor pilot and he flew Helicopters such as SH3D and EH101 mostly in support of amphibious and special forces operations and JPR. He is currently serving as the Joint Personnel Recovery, Littoral and Special Operations Subject Matter Expert at the Joint Air Power Competence Centre.

Convoy: © US Army, Sgt. Sarah D. Williams; Soldiers: © Gorodenkoff/shutterstock; Tank: © US Army; Apache: © Lockheed Martin; Global Hawk: © Northrop Grumman Corporation; Landscape: © danfador/pixabay

Manned-Unmanned Teaming

A Great Opportunity or Mission Overload?

By Lieutenant Colonel Livio Rossetti, ITA A, JAPCC

Introduction

In the next decade, a number of nations will replace or update their current helicopter fleets.[1] Aware of this, the NATO community has set up different working/study groups, to determine the requirements for the new generation of combat/transport helicopters. Manned-Unmanned Teaming (MUM-T) capability could

be one of these requirements. The technology and the capabilities offered by the MUM-T concept may likely revolutionize not only the way in which future aircraft might be developed, but perhaps even how future warfare might be conducted. This article provides an overview of the MUM-T concept. It explores opportunities and capabilities, and analyses aeromedical and human factors challenges which could be posed by the increased pilot's workload on manned platforms when operating in a MUM-T environment; factors that could influence the development of new concepts of the Human-Machine Interface (HMI).

What is MUM-T?

During the 2013 MUM-T Strategy Brief, the United States Army Aviation Centre (USAACE) defined MUM-T as: 'The synchronized employment of soldier, manned and unmanned air and ground vehicles, robotics, and sensors to achieve enhanced situational understanding, greater lethality, and improved survivability.'[2] Donald Woldhuis and Michael Spencer explain MUM-T as 'a standardized systems architecture and communications protocol that enables live and still images gained from the sensor payloads of Unmanned Aerial Systems (UAS) to be shared across a force'.[3] Through the use of sophisticated data links, MUM-T lets the manned platforms connect with UAS at different Levels of Interoperability (LOI). This makes it possible for both manned aircraft and ground forces to share the UAS's products. This opportunity may enhance decision-making and mission effectiveness, offering new different tactical chances which could make a difference in the development of future strategies. In simple terms, MUM-T offers a new LOI between ground forces, manned aircraft, and UAS.

Opportunities and Capabilities

In the rotary wing domain, the Attack Helicopter AH-64E could be considered to be one of the most advanced MUM-T platforms. Able to perform from LOI-2 to LOI-4 (Table 1), it not only receives videos from Unmanned Aircraft (UA), but can also control the UA's sensors and navigation profile.[4] The imagery could be provided to the infantry and Joint Terminal Attack Controllers (JTAC), supporting the need for tactical information collection of joint force leaders, and increasing tactical Situational Awareness (SA).[5] MUM-T offers the opportunity to know what is happening on the ground, what the target looks like, and what the terrain looks like, all before you get there, while still far away from the danger zone. It offers the possibility to provide the involved actors with the same picture. The capability for the helicopter crews, to assume control of the UA or its payload, and to autonomously manage the imagery collection needed to accomplish the given mission, without going through a third-party operator, could lead to a drastic reduction

Levels of Interoperability (LOIs)	
Level 1	Indirect receipt of UA-related data.
Level 2	Direct receipt of ISR/other data where 'direct' covers reception of the UA data by the UCS when it has direct communication with the UA.
Level 3	Control and monitoring of the UA payload in addition to direct receipt of ISR/other data.
Level 4	Control and monitoring of the UA, less launch and recovery.
Level 5	Control and monitoring of the UA (Level 4), plus launch and recovery functions.

Table 1: NATO's STANAG 4586 describes five LOIs.

of the communication necessary to positively identify a target and to determine the positions of friendly forces and neutral entities on the ground. These are aspects which might avoid break downs in communication due to language barriers and which reduce the risk of errors, misunderstandings or misidentification of a target. The opportunities and capabilities offered by the MUM-T concept depend significantly on the possible roles which a UA could assume when teamed with a manned aircraft. In a recent study, Allied Command Transformation (ACT) examined some of these possible roles.[6] A UA can be used as a sensor to feed information to the manned aircraft. It can also be considered as a Weapons Delivery (WD) platform, capable of launching ordnance. Coupled with a manned aircraft, a UA can be used as a decoy, either attracting the opponent's weaponry or distracting the enemy to allow the manned platform to proceed undetected, increasing their security bubble as much as possible. Electronic attack (EA) could be considered, too. Teamed with this role, a UA could emit electromagnetic energy to overwhelm, confuse, deceive or otherwise render ineffective the radar system of an enemy counterpart. A Search and Rescue (SAR) payload could be a possible UA role. A UA could be driven by a manned aircraft and used to drop supplies for a rescue mission (e.g., food, medicine).[7] MUM-T has the potential to offer a variety of opportunities, which, combined with up-to-date Tactics, Techniques, and Procedures (TTP), could furnish improved and augmented tactical SA during all phases of a mission and could enhance the lethality of the manned platforms and improve their survival chances.

Interoperability

The number of different types of unmanned systems being used in different domains will increase significantly in the future. In the civil sector, for example, it is estimated that the global market related to unmanned aircraft could reach approximately USD 14 billion in 2026, a 300 % increase compared to 2017.[8] In this complex and continuously evolving technological scenario, the assurance of interoperability between different manned/unmanned systems available to the NATO community represents a growing problem. UAS are designed and procured nationally.[9] They are usually built using unique and specific systems which do not ensure a common interface. 'Commonality of hardware and software would be a solution to achieve interoperability, but the commonality is not mandatory' within the NATO community.[10] The result is an increasing number of non-interoperable

systems. NATO responded to interoperability requirements in 2004 by ratifying the first edition of Standardization Agreement 4586 (STANAG 4586 – Standard Interfaces of Unmanned Aircraft (UA) control system (UCS) for NATO UA interoperability), of which edition 4 is currently effective.[11] STANAG 4586 does not provide a complete solution but, as stated by Mário Monteiro Marques in the conclusion of his study: 'It is certainly a crucial step taken in that direction, providing a roadmap for future development.'[12] Considering that commonality is not mandatory within NATO, convergence on a common roadmap should represent a valid solution for developing interoperable and connectable systems.

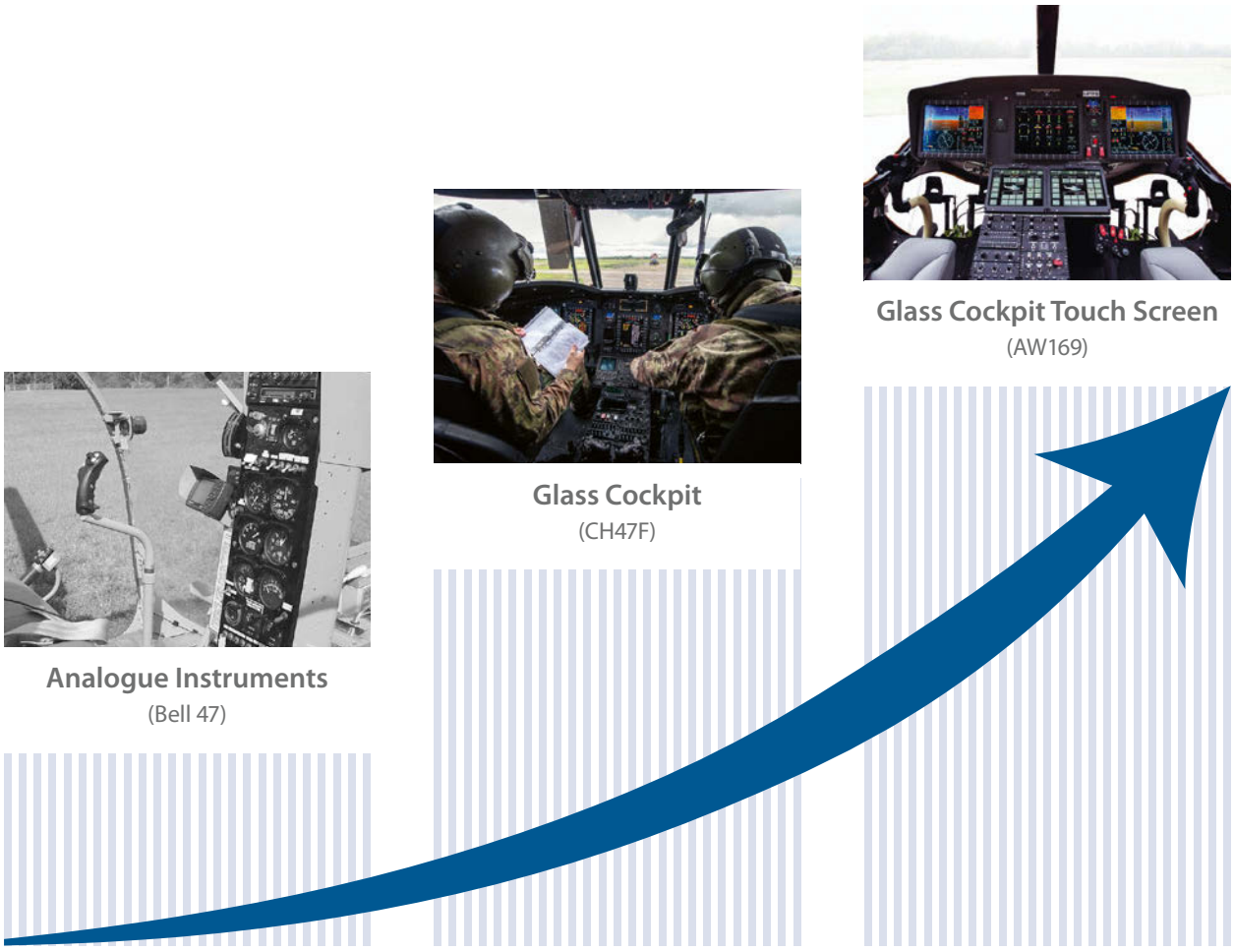
Human Factors and Aeromedical Challenges

Task saturation and excessive workload may become a serious problem for pilots of manned platforms, when teamed with a UA, performing a MUM-T mission. In 2015 the United States Army Aeromedical Research Laboratory (USAARL) focused on this issue and conducted a study analyzing Human Factors (HF) and aeromedical challenges which could be posed by MUM-T applications.[13] The study highlighted the absolute necessity of remaining vigilant. As indicated by USAARL, some of the possible problems that pilots might face when operating in MUM-T mode include visual overload, increased workload, task saturation, distraction and decreased 'flying' SA, as well as motion sickness. Moreover, USAARL warns that processing conflicting sensory information (between aerial platform motion cues and UA orientation), and other consequences of increased UA interoperability in the cockpit, may increase the risk of Spatial Disorientation (SD). The USAARL distinguishes between 'battlefield' or 'target' SA, and 'flying' SA. MUM-T could increase the first, but USAARL raises the fundamental question that this might result in decreased 'flying' SA, as a cost. In light of the above, the aviation medical community should be involved, more than ever, in the development cycle of future MUM-T capable aircraft, providing, guidance, and expertise. Analyzing HF and aeromedical challenges posed by MUM-T applications, it would be desirable to have a holistic and comprehensive approach to involve the essential actors: not only aviation medical community but also the scientific community, research entities, and industry. In 2012 Tobias Paul and Emanuel Brämer investigated the MUM-T concept and highlighted the necessity of additional and enhanced systems in the cockpit of the manned platforms, to allow successful teaming with a UA.[14] The systems should reduce the pilot workload to an acceptable level while providing them with appropriate SA. Enhanced HMI for task assignment, presentation of UA status, and presentation of task results, was one of the crucial components to be realized[15]. In this context, the Helicopter Division of Leonardo is developing a new objective methodology which can evaluate the effectiveness of the HMI called Infrared Stress Monitoring System (ISMS).[16] This project is 'aimed at validating metrics based on psycho-physiological indexes, to evaluate the real-time objective crew workload throughout their cognitive and stress behaviour and indexes'.[17] Recognizing and mitigating the potential for performance degradation, errors, and accidents caused by HF and aeromedical risks has always been paramount in aircraft design and development. This perspective is particularly relevant in the development of MUM-T technology applied to manned aerial platforms. Exploring new methods of HMI which facilitate natural and efficient interaction, while reducing pilot workload as much as possible, could represent a truly essential element in the evolution of the new/next generation of MUM-T capable aircraft.

'MUM-T can be described as a new combat strategy. It could enhance tactical SA and the lethality of the manned platforms while improving their survival chances.'

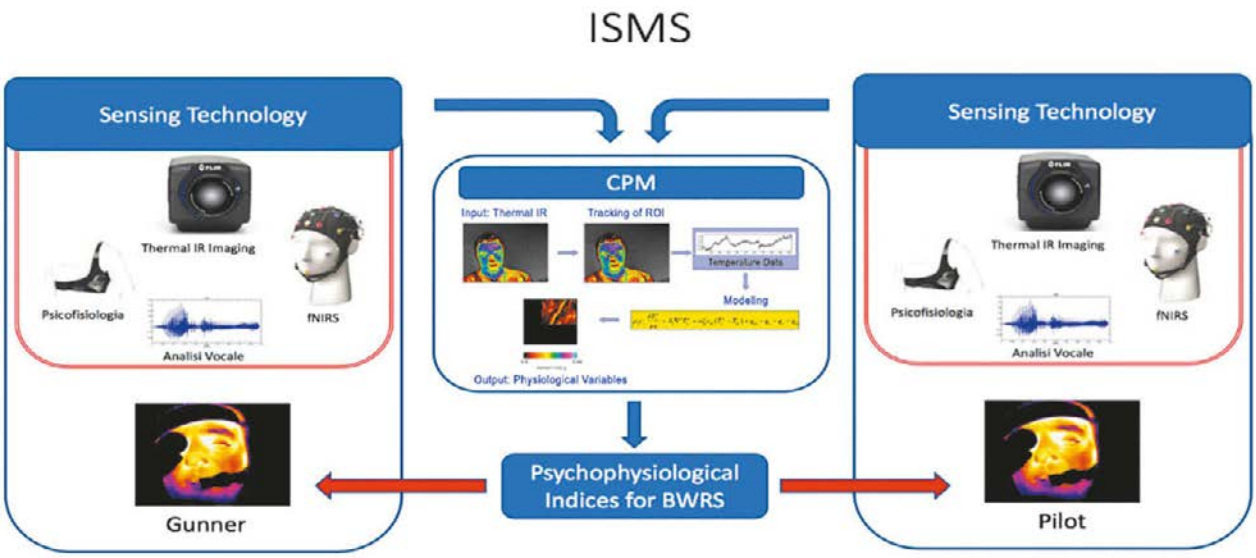
Conclusions and Recommendations

MUM-T can be described as a new combat strategy. It could enhance tactical SA and the lethality of the manned platforms while improving their survival chances. It is a relatively new technology which aims to synchronize the employment of the actors involved



HMI-Cockpit Evolution.

(soldiers, manned and unmanned air and ground vehicles, robotics and sensor). The innovative concept of action could revolutionize the planning and conduct of warfare in the future. Some challenges need to be addressed, and some problems to be solved before creating a valid and reliable tool for NATO. First, in the development of the technologies applied to MUM-T, particular importance has to be given to the concept of interoperability. The convergence on a common roadmap, by all the countries involved, should represent a valid solution for developing interoperable and connectable systems. This could ensure tactical and strategic advantages for commanders in the future, providing different coupling options between available MUM-T platforms within NATO. Second, the accurate and scientific study of HF and aeromedical issues/risks/threats posed by MUM-T applications are crucial in the design and development of future aircraft. A holistic and comprehensive approach from the involved actors is desirable to face the challenges. An objective analysis of the crew's workload could be useful in supporting the cockpit design of the new aircraft and driving the development of new HMI concepts. These concepts could help to find the right way to display the essential data needed by the pilots, without exceeding their human limits. In conclusion: the MUM-T strategy enhances Air to Land Integration at tactical level, by putting air and ground forces quite literally in the same picture. With due respect for the multiple technological challenges it implies, could be considered a great opportunity, which the NATO community needs to assess carefully. ●



© Courtesy of ISMS Team

The ISMS is aimed at the validation of a metrics based on psychophysiological indexes to evaluate *the real-time crew workload and stress* throughout their psychophysiological biomarkers, non-invasively recorded.

1. NATO Science and Technology Organization, 'Future Rotorcraft Technologies', *Technical Memorandum, Final,* (8 Jun. 2018): p. 16. Retrieved 22 May 2019, from NATO Defence Investment: https://diweb.hq.nato.int/SearchCenter/Pages/Results.aspx?k=Future%20Rotorcraft%20Technologies&s=All%20Sites
2. Taylor M., (Jul. 2014), 'Manned-Unmanned Teaming Training is the Key Ingredient', (U. A. Excellence, Ed.) Aviation Digest – United States Army Aviation, 2(1), 5. Retrieved 22 May 2019, from: https://www.rucker.army.mil/aviationdigest/archive.html
3. Woldhuis, D., Spencer, M. (10 Dec. 2017), Manned-Unmanned Teaming: 'MUM-T's the Word' – Donald Woldhuis & Michael Spencer. Retrieved 20 May 2019, from The Sir Richard Williams Foundation: http://centralblue.williamsfoundation.org.au/manned-unmanned-teaming-mum-ts-the-word-donald-woldhuis-michael-spencer/
4. Apache Block III – Teaming With Unmanned Aircraft In Battle (24 Jan. 2015). Retrieved 28 May 2019 from YouTube: https://www.youtube.com/watch?v=KJClODcNkC4
5. Cole, M. (Jul. 2014). New Manned-Unmanned Aircraft Opportunities. (U. A. Excellence, Ed.) Aviation Digest – United States Army Aviation, 2(3), 13–16. Retrieved 29 May 2019, from: https://www.rucker.army.mil/aviationdigest/archive.html
6. Andrea P. Williams, P. D. (undated). Autonomous Systems – Issues for Defence Policymakers. 271–272. Norfolk, Virginia, United States: Allied Command Transformation. Retrieved 28 May 2019, from: https://apps.dtic.mil/dtic/tr/fulltext/u2/1010077.pdf
7. Ibid. 6.
8. Leonardo Company, (19 Jun. 2017), 'A Hero for our times'. Retrieved 24 Jan. 2019, from Leonardo: https://www.leonardocompany.com/en/news-and-stories-detail/-/detail/hero
9. NATO Standardization Office (5 Apr. 2017). 'Standard Interface of Unmanned Aircraft (UA) Control System (UCS) for NATO UA interoperability – Interface Control Document'. AEP-84 Volume I. Retrieved 21 May 2019, from: https://nso.nato.int/nso/nsdd/_CommonList.html
10. Ibid. 9.
11. Ibid. 9.
12. Marques, M. M. (Jan. 2015). STANAG 4586 Standard Interface of Unmanned Aircraft (UA) Control Systems (UCS) for NATO UAV Interoperability. (N. A. Organization, Ed.) North Atlantic Treaty Organization Science and Technology Organization web page. Retrieved 21 May 2019, from NATO Science and Technology Organization: https://www.sto.nato.int/publications/pages/results.aspx?k=STANAG%204586&s=Search%20All%20STO%20Reports
13. Gaydos, S. J., & Curry, I. P. (Apr. 2015). 'Manned-Unmanned Teaming: Expanding the Envelope of UAS Operational Employment (Reprint)'. US Army Aeromedical Research Laboratory. Retrieved 17 May 2019, from: https://apps.dtic.mil/docs/citations/ADA623893
14. Paul, T., & Bramer, E. (Aug. 2012). 'Operational Considerations for Teaming Manned and Unmanned Helicopter'. Retrieved 5 Jun. 2019, from University of Lincoln: https://eds.a.ebscohost.com/eds/detail/detail?vid=37&sid=b6a9f6ad-339c-4cd6-8776-0959d2346fd1%40sdc-v-sessmgr01&bdata=JnNpdGU9ZWRzLWxpdmUmc2NvcGU9c2l0ZQ%3d%3d#AN=84364463&db=edb
15. Ibid. 14.
16. Gazzaniga, M., Sanguini, R., & Merla, A. (2018). Neuroscience based Approach for designing Future Cockpits. Polaris Innovation Journal, 54–57.
17. Ibid. 16.

Lieutenant Colonel Livio Rossetti

was commissioned in the Italian Army in 1993, as an infantry officer. After three years he transited to the Army Aviation schools and graduated as a rotary-wing pilot in 1998. Lieutenant Colonel Rossetti has served as Platoon Commander, Squadron Commander, and S3-cell Chief. He has flown utility helicopters AB-206, AB-205, AB-212, AB-412, as well as the AW-129, Mangusta, combat helicopter. As an aircrew and staff officer, he has deployments to the Balkans Peninsula (Albania, Kosovo), Middle East (Lebanon, Iraq) and Central Asia (Afghanistan). Lieutenant Colonel Rossetti is a qualified CBRN (Chemical, Biological, Radiological and Nuclear) specialist, an airmobile instructor, and he is currently stationed at the JAPCC – Kalkar, as Air-Land Operations expert in the Combat Air Branch.

F-35: © 2013 Darin Russell, Lockheed Martin; Tunnel Light Effects: © xresch/pixabay; Code: © Comfreak/pixabay; Soldier: © Bignai/shutterstock; Tunnel: © Air National Guard photo, Senior Master Sgt. Beth Holliker

Multi-Domain Operations: Inconceivable!

'You keep using that word. I do not think it means what you think it means.' – Inigo Montoya[8]

By Lieutenant Colonel Henry Heren, USA AF, JAPCC

Introduction

The classic line above from *The Princess Bride* is in response to one of the characters, Vizzini, repeatedly declaring 'inconceivable!' during a series of events which in the outcomes are not only conceivable but accomplished through some ingenuity by the hero, Westley.

One of Vizzini's accomplices, Inigo, having heard the exclamation multiple times delivers the line in an effort to be both helpful and humorous. Unfortunately, an increasing number of NATO military members are taking part in professional conversations on a daily basis using terms about which they possess as little understanding as Vizzini about the word 'inconceivable'.

Chief among the current list of readily-used yet misunderstood terms is Multi-Domain Operations (MDO). Indeed, the pursuit of understanding of the meaning of this term was sufficient for the Joint Air Power Competence Centre to select MDO as the theme for their flagship conference which took place in Essen, Germany the 8th–10th of October 2019.[1]

The challenges to understanding MDO begin with a lack of a clear, agreed-upon definition of the term itself, and what the concept entails for the military planners and operators who must prepare for and undertake such operations. To better understand what is meant by MDO we must examine the origins of the term, what the term means (or could mean) and, finally, what the term means for modern militaries in the future.

Part One

The conversation begins with where, or perhaps why, the term first came to be utilized. Modern militaries, particularly those within NATO, have for decades used the term *Joint* when discussing operations coordinated across multiple domains (land, sea, and air). However, *Joint*[2] Operations is a term and concept rooted in operations involving more than one service (army, navy, and air force). The term MDO differs from *Joint* Operations in that it is intended to focus on operations across multiple domains regardless of service affiliation, not necessarily on those conducted by multiple services. This new term originated from the need to describe operations which included those domains lacking definitive service representation. Specifically, the United States Air Force (USAF) views Multi-Domain as those operations in the air, space and cyberspace domains conducted by members of the USAF,[3] while the United States Army considers MDO as the way it 'can counter and defeat a near-peer adversary capable of contesting the U.S. in all domains'.[4] However, the incorporation of MDO into the common lexicon did not change the nature of the operations, or even the perceptions of operators, nor was there a demonstrable change in the services' willingness to operate outside of their given service-centric domains.

The reality is that today's modern military operators, with extremely few exceptions, rely on capabilities in other domains as they execute military operations in their own primary domain. This is true in so many modern military operations that it is difficult to think of operators who execute operations solely in a single domain, without support from capabilities in other domains. What is needed, then, is a term which allows military members to speak in terms greater than merely synchronization and coordination. If militaries are to truly enter an era of MDO, the concept must be endorsed and practised by operators who are actually operating in multiple domains simultaneously. This will be a significant paradigm shift from today's operations which, by and large, focus more accurately on merging operations of single domains while coordinating activities with operators focused on their domains. To realize this new reality military professionals will need to ensure they have a clear understanding of, and agreement on, the terminology, and that they incorporate the technology which will allow those operators to plan and conduct MDO.

Defining MDO

All agree the term 'multiple' refers to more than one. The issue becomes complicated when military professionals attempt to reach agreement on the meaning of the term domain, at least with regard to military operations. The term 'domain' is utilized through military writing today, and yet the term lacks an agreed-upon definition within the military context. The only way military members treat a domain officially is after acknowledgement of the said domain by political leaders. However, this gives military professionals only a politically acceptable definition, which may differ from the reality within which those same professionals must plan and operate. Lastly, the term domain has numerous connotations outside of the military construct, and so the military is in need of not only clearing defining domain for itself, but also ensuring the term is differentiated from usages outside of the military context. Therefore, this article proposes that the term 'operational domain' be employed. This term is derived from NATO's use of

© US Marine Corps, Cpl. Jodson B. Graves

'domain of operations' in recognizing cyberspace during the Warsaw Summit in 2016[5], with the following working definition:

Operational Domain: An unique area of territory or interest in which a military force can execute the joint functions (intelligence, information, command and control, fires, movement and manoeuvre, protection, and sustainment)[6] in pursuit of mission accomplishment. Operational domains can be further divided into operational environments, which are subsets which require special (although not wholly unique) considerations (e.g., land is an operational domain, with forest and desert operational environments).

It is worth noting there are other recommendations for a military definition of the term domain. Indeed, Dr. Jeffrey Reilly (Multi-Domain Operational Strategist Program Director at the USAF Air Command and Staff College) has proposed that a domain is a 'critical macro manoeuvre space whose access or control is vital to the freedom of action and superiority required by the mission'.[7] The objective here is not settling the discussion with regard to how to define the term domain, rather compel a decision on a military-applicable definition that military professionals can all utilize moving forward. Still, for this article, a sufficient definition is available to explore those operations which would encompass capabilities used across multiple domains or MDO.

Focus of MDO

The focus for MDO should be on the military operator(s), executing operations in multiple domains simultaneously. Military professionals must differentiate, in our minds, conversations and writings, between the operator who is operating in multiple domains (both manoeuvring and firing, in particular) from the operator who is operating in one domain while using support (sustainment, intelligence, command and control) from another domain as a utility … the first is an example of a Multi-Domain operator, and the second is, in reality, a Service, or perhaps, Joint Operation. An underlying principle is that all domains within the modern military construct are interdependent; discussions of the level of dependence or interdependence amongst domains are distracting and provide no real benefit to the further development of military thought.

Wargaming

As stated previously, there are currently few examples of Multi-Domain operators in the military, as most military members concentrate on operating within in a single domain while utilizing capabilities from other domains as support or utility mechanisms. To better

understand the concept of MDO across a larger audience an analogy is useful … consider video games. One popular type of video game today is referred to as a first-person shooter. In these games, the player (operator) controls an avatar which moves through the game world executing various tasks (operations). These tasks might be accomplished while using a handheld weapon, driving an armoured vehicle, or piloting a craft across the water, in the air, or even in space. These games capture the concept of single domain operations rather succinctly, with the player operating in one domain and potentially utilizing capabilities of other domains for support (wireless communications, air support, etc.).

However, there is another genre of game referred to as real-time strategy games. In these games the player has limited direct (tactical) control over individual weapon systems, rather the player controls types of units in concert (operational control). Moreover, the player is often responsible for collecting resources, building centralized operating locations and generating the various units under the player's control (sustainment and protection). The player (operator) must not only possess an understanding of the various functions, operational capabilities, and domain-unique characteristics of the various capabilities under his/her control, he/she must synchronize actions and fight in the various domains for some level of control. This analogy for MDOs, if accepted, raises questions about developing capabilities to allow this type of operation, the development of the military members to execute such operations, and even the potential to redefine the concepts delineating command and control at the tactical and operational levels.

For the moment, this article will leave the capabilities to be developed (autonomous vehicles and artificial intelligence will continue to develop and improve) and the issues surrounding tactical versus operational command and control alone. Others are already extensively looking at multi-domain command and control, in some cases having skipped over the issues

covered in this article. Instead, this article will turn to consider the professional development of the future Multi-Domain operator.

MDO in NATO

The manner in which NATO nations currently grow and develop members of their military is generally focused on tactical competency and depth within one of many specific weapon systems. The associated processes have been developed and refined over the millennia in professional standing militaries around the world. In more recent years there has been a push to develop, in some (particularly at the Field Grade Office [FGO]-Level), a degree of operational-breadth to facilitate Joint Operations. This has been perceived as necessary due to the anticipated (and realized) synergistic benefits of the combined employment of the various weapon systems utilized by the many nations. However, technological advancements, coupled with widespread use and familiarity with those same technologies, have rendered the professional military member, groomed in tactical expertise, insufficiently prepared for the needs of the modern and future battlefield. Professional military members are now (and will increasingly be) required to have tactical depth and a degree of breadth at all levels (strategic, operational, and tactical) to enable them to operate in multiple domains simultaneously and in a manner to best achieve mission objectives. This presents challenges for militaries organized by function or domain, specifically in terms of freedom of manoeuvre as well as command and control. It also presents challenges for nations who are developing these professional warriors uniquely within each service and in dissimilar fashions in search of (what should be) increasingly similar results.

Conclusion

Moving forward into an era of MDOs, at least in terms of capability development, military professionals must ensure the lexicon evolves to accommodate and encompass new ideas and new concepts instead of merely creating new terms for old ideas. With regards to MDO, this presents the possibility of a significant change in the way in which militaries approach operations, and prepare their operators. For this to happen, military professionals must discard tired arguments involving which domains are more crucial and must reach an agreed-upon definition for terms, many of which are already in daily use. Failure to do so will impede the growth of military concepts which will be crucial in the battlefields of tomorrow and will risk creating innumerable Vizzini's unable to comprehend the competitions and conflicts they face. ●

1. https://www.japcc.org/conference/
2. 'Joint: adjective used to describe activities, operations and organizations in which elements of at least two services participate.' AAP-06, NATO Glossary of Terms and Definitions 2018, p. 70.
3. Doolittle Series 18: Multi-Domain Operations, Air Force Leeson Learned Air University Press, Maxwell Air Force Base, Alabama 2019, p. 3.
4. https://www.tradoc.army.mil/Publications-and-Resources/Article-display/Article/1655556/multi-domain-operations/. Accessed 1 Aug. 2019.
5. NATO Warsaw Summit Communique, 9 Jul. 2016, https://www.nato.int/cps/en/natohq/official_texts_133169.htm, '… recognise cyberspace as a domain of operations in which NATO must defend itself as effectively as it does in the air, on land, and at sea.'
6. US Joint Publication 3-0, *Joint Operations*, 17 Jan. 2017, Incorporating Change 1, 22 Oct. 2018, p. III–1.
7. https://othjournal.com/2018/09/17/defining-the-domain-in-multi-domain/. Accessed 23 Jul. 2019.
8. Reiner, R. (dir.), (1987), *The Princess Bride* [DVD]. Columbia TriStar Home Entertainment.

Lieutenant Colonel Henry Heren

is a NATO Space & Cyberspace Strategist assigned to the JAPCC. He is a Master Space Operator and a Fully Qualified Joint Staff Officer with more than 27 years' active duty experience in the US Air Force. He is a Graduate of the US Air Force Weapons School, with experience in assignments focusing on Space, Cyberspace, and Electronic Warfare Operations.

A Comprehensive Approach to Countering Unmanned Aircraft Systems

And Why Current Initiatives Fall Short

By Lieutenant Colonel André Haider, DEU A, JAPCC

Introduction

Over the last decades, Unmanned Aircraft Systems (UAS) have been fielded in every military service, ranging from handheld micro-UAS to medium-sized tactical systems to fully grown and Remotely Piloted Aircraft (RPA). At the same time, the civilian market has witnessed an exponential growth of predominantly smaller systems intended for public and recreational use. However, the latter use case has gained the attention of law enforcement agencies and military force protection communities due to the increased misuse of Commercial-Off-The-Shelf (COTS) 'drones' near and over airports, public events and military installations.

Recently, various industry players reacted to the emerging demand for capabilities to defend against these COTS UAS by developing Counter-UAS (C-UAS) sensors and effectors. These systems are specifically designed to detect, track and engage Low, Slow and Small (LSS) flying objects, ranging from man-portable systems such as 'Droneguns'[1–3] to truck-mounted models such as the 'Silent Archer'[4]. NATO also reacted to this new threat by conducting a series of studies centred on defence against LSS air threats[5–7] and by establishing a C-UAS Working Group with a focus on terrorist misuse of UAS.[8]

However, technology is developing rapidly, in many cases, faster than the defence industry or NATO can react. For example, many 'traditional' countermeasures against small UAS rely on electronic jamming of the command and control link between the 'drone' and its remote control. Many current COTS products are, however, able to navigate autonomously to a given coordinate or can be controlled via a GSM network

MQ-9: © Digital Storm/shutterstock; Quadcopter: © sdecoret/shutterstock

from the operator's mobile phone. These features make jamming either completely useless, since the Command and Control (C2) link is no longer required to navigate, or, because of peacetime restrictions, the frequencies that need to be jammed are often off-limits, as they are used by the public.

Additionally, a sole focus on the low, slow, and small end of the C-UAS spectrum covers only a fraction of current UAS technology and excludes most military applications. Peer competitors to NATO can be expected to employ UAS at the same level of technology, and under comparable operational principles, as in the Alliance. Consequently, NATO has to anticipate enemy use of UAS in the same mission sets as with friendly UAS, covering the spectrum from Intelligence, Surveillance & Reconnaissance to unmanned airstrikes, conducted in Line of Sight (LOS) as well as Beyond Line of Sight (BLOS) operations, utilizing the electromagnetic spectrum and the space domain in the same way as NATO.

The following sections briefly describe a spectrum of C-UAS considerations and why the current focus on the low, slow, and small end, although imminent and essential, is not sufficient to cover all aspects of defence against potential adversary UAS engagements.

The Spectrum of Countering Unmanned Aircraft Systems

To understand the full spectrum of countering UAS, it is important to note that exclusively focussing on the Unmanned Aircraft (UA) or 'drone' does not provide a complete picture. UAS are grouped into several categories and consist of numerous components, depending on their size and application.

Unmanned Aircraft System Components. The basic setup of a small UAS consists of an operator, a remote control, a C2 link and the aircraft or 'drone' itself. Larger systems, such as the one depicted in Figure 1, may also incorporate a dedicated Ground Control Station (GCS) for Launch and Recovery as well as a Mission Control Element (MCE) for conducting the operation. The larger systems typically utilize space-enabled BLOS communications for the C2 and data links. GCSs and MCEs consist of physical infrastructure such as trucks and containers or buildings, which typically host the computer hardware and software that, in turn, run the applications required to operate the overall system.

As a general rule, the larger the UAS, the larger the requirement for infrastructures such as shelters, runways, airfields or airports. The same is true for the amount of logistics, such as fuel, ammunition, and maintenance.

Finally, unmanned systems always require personnel to operate them. This can vary from a single individual operating a small 'drone' up to multiple aircrew rotating in shifts for larger systems. Higher class military UAS performing collection missions also require a significant amount of Processing, Exploitation and Dissemination personnel to analyse the information provided by the UAS.

Unmanned Aircraft System Categories. NATO categorizes UAS into three dedicated classes, ranging from Class I for the micro, mini and small ones, to Class II for medium-sized, tactical systems, to Class III for Medium-Altitude Long-Endurance (MALE) and

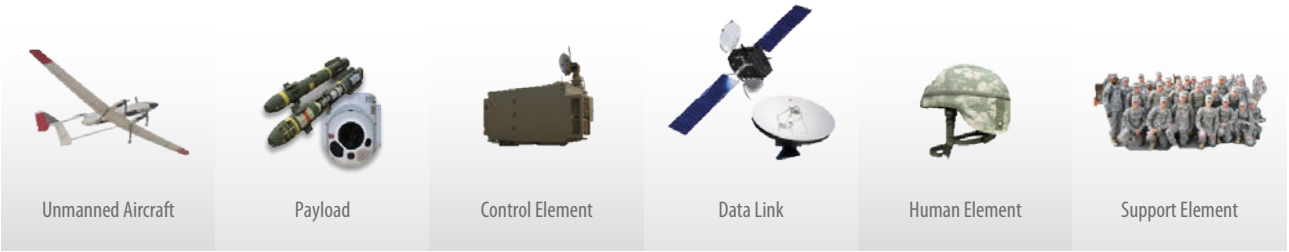


Figure 1: Unmanned Aircraft System Components.

High-Altitude Long-Endurance (HALE) aircraft. By looking at the three different classes, their application, size and operating altitude alone, it can be concluded that countering this spectrum of UAS requires a multitude of different, class-specific approaches.

Countermeasures' Points of Attack

Figure 2 provides an overview of UAS components and their relative spatial arrangements. Depending on the component itself, the domain it is operating in and its potential distance to NATO forces, there are different points of attack presented as options for the employment of countermeasures. While these points of attack can be addressed by the missions described in the sections below, all should complement each other and contribute to a comprehensive, multi-domain C-UAS effort.

Force Protection (FP). LSS UAS are readily available as COTS products to anyone and pose an imminent threat to critical public infrastructure and military installations. Force protection measures assuring the safety of friendly forces and critical infrastructure are typically very localized and focused on the area which requires protection. Natural and human-made obstacles such as trees or buildings can cover an approach of LSS UAS and significantly delay the detection of these objects in the area, further shortening available reaction time. Force protection measures should primarily be aimed at denying access of UAS to the protected area. However, it may also be desirable to safely capture the UAS for intelligence purposes.

Air Defence (AD). Larger UAS can operate at altitudes of up to 30,000 ft., and in some cases even higher. The Radar Cross Section of these UAS is comparable to any other non-stealthy aircraft, hence they

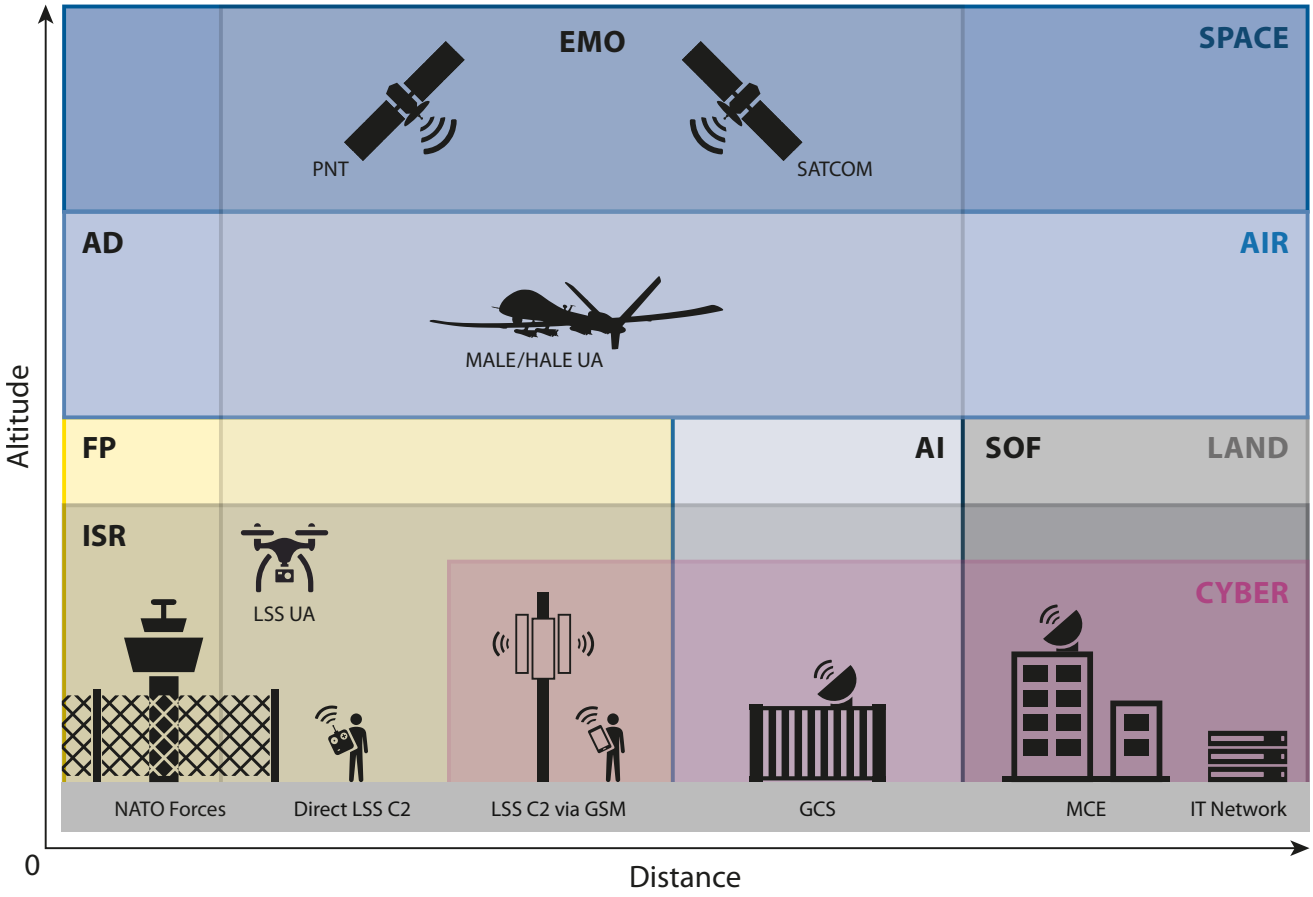


Figure 2: Spatial Arrangement of Unmanned Aircraft System Components.

can be detected and engaged by most Air and Missile Defence (AMD) systems. However. Modern surface-to-air ammunition is not cheap and is designed to engage high-value targets. Large numbers or a swarm of low-cost UAS may quickly turn the cost-benefit ratio of traditional AMD upside down and render current systems inefficient. Short-Range Air Defence and even legacy Anti-Aircraft Artillery may provide an effective, but also efficient, defence against UAS.

Air Interdiction (AI). Launch and Recovery of larger UAS is typically conducted from a GCS inside or near the mission area. GCS can be mobile and mounted on a truck or stationary when placed on the ground, e.g. near an airfield. In any case, the Launch and Recovery Element (LRE) of larger UAS is a high-value target as it is often responsible for launching and recovering several UA. Eliminating an LRE will likely bring UAS operations to a halt in the respective area as new UAS cannot be launched anymore and airborne ones cannot be recovered safely.

Special Operations Forces (SOF). Once airborne, larger systems can often be handed over from the LRE to an MCE and operated BLOS via Satellite Communications (SATCOM). The MCE can be located far outside the mission area, probably deep inside the adversary's territory and utilizing a hardened infrastructure. NATO Special Operations Forces may be employed as a means to attack the enemy's MCE itself, take out the SATCOM ground nodes which are essential for UAS BLOS operations, or even kill adversary combatants such as UAS crew members during their time off base.

Cyber Warfare. UAS are entirely dependent on their computer systems, information technology and network connectivity. Control stations, especially inside fixed installations such as an MCE, are potentially vulnerable to attack through cyberspace, exploiting security vulnerabilities of their hardware and software but also by taking advantage of human failure, negligence or susceptibility. COTS UAS being operated via a GSM network are likely only accessible through the cyberspace domain since countermeasures in the electromagnetic spectrum may be off-limits, e.g. if frequencies are publicly used.

Electromagnetic Operations (EMO). C2 of UAS is conducted via LOS or BLOS radio transmissions and typically also reliant on Position, Navigation, and Timing (PNT) signals. Electromagnetic Operations can be used throughout all tiers of UAS to hinder and disrupt C2 and PNT transmissions or even to spoof PNT information to divert or land the UAS. However, 'traditional' Electronic Warfare has its limits with modern models of UAS which are capable of autonomous flight and are no longer reliant on continuous data links. However, upcoming Directed Energy Weapons such as High Power Microwaves or High Energy Lasers may add kinetic capabilities to the electromagnetic portfolio and could be used to render sensor payloads inoperable or destroy the UA itself.[9]

Intelligence, Surveillance, Reconnaissance (ISR). Detecting UA in flight is often the first step in defending against them. Larger UA can be detected even with legacy radar systems, whereas LSS UA require more specialized equipment to distinguish them from clutter, e.g. leaves and birds. However, apart from airspace surveillance, reliable identification of the intruding UAS and its capabilities, as well as identifying the origin of the C2 transmission, is critical for selecting appropriate countermeasures. For example, this includes information about the capabilities and the level of autonomy of the UA, locations of adversary LREs and MCEs, as well as SATCOM assets and frequencies used. C-UAS systems have to be fed with this information, preferably in real-time, to process a suitable target solution.

The Space Domain. Space-based communications are an essential part of BLOS UAS operations. But COTS UAS also utilize PNT signals provided by respective satellite constellations. Within the limits of the 'Outer Space Treaty', countermeasures against space-based communications and PNT may be a legitimate option to defend against an entire fleet of adversary UAS. This does not necessarily require kinetic engagements by anti-satellite weapons. Indeed, ground or space-based jamming capabilities could be effective without risking large amounts of debris which could render entire orbits unusable for mankind.

Legal Considerations for the Application of Countermeasures

Applications for UAS range from public and recreational purposes to military missions including airstrikes. Consequently, depending on their use, defending against these systems is governed by either domestic or international law, and the legal framework that needs to be applied is also dependent on whether it is peacetime or wartime.

Peacetime vs Wartime. Defending against UAS is not only a wartime requirement. Frequent incidents[10, 11] have already proven that COTS 'drones' can easily be flown into restricted airspace and are able to stop an entire airport's flight operations. It is only a question of time before the first incident will be witnessed over military installations, e.g. air bases, headquarters or military training grounds.

Depending on the country and its domestic law, which is applicable during peacetime, circumstances may prohibit certain types of countermeasures and limit the options for defending against UAS. These possibly prohibited countermeasures include kinetic engagement of airborne unmanned systems, jamming of publicly used frequencies, such as GSM or wireless networks, or interference with the commercial PNT signals.

In general, it can be assumed that countering UAS in peacetime will be subject to a multitude of civilian restrictions which may or may not fully apply in a conflict scenario. C-UAS doctrine and Tactics, Techniques and Procedures (TTP) need to include these particulars and adhere to individual legal environments.

Law Enforcement vs Military Engagement. In peacetime, the responsibility for the defence against 'drones' and UAS typically lies with civil law enforcement agencies. However, responsibilities may overlap near military installations and critical infrastructure. Moreover, law enforcement agencies may require military support since the equipment to detect, identify and engage UAS might only be provided by the armed forces.

Airport: © Mohd Syis Zulkipli/shutterstock; Drone: © krepnox/pixabay

Hence, close cooperation and coordination between civilian law enforcement agencies and the armed forces are essential for a comprehensive C-UAS approach. Mutual exercises could help establish common C-UAS TTPs and ensure an effective level of interoperability between civil and military organizations.

Public Safety and Collateral Damage. The protection of civilians from harm is the primary principle of both international as well as domestic law. Therefore, defence against UAS requires consideration of the potential risks to human life, both in peacetime and in wartime. Civilians may be endangered by kinetic measures such as the shooting down of UA or an attack on its ground facilities.

Additionally, non-kinetic measures such as jamming radio frequencies or PNT signals may affect public and commercial communications infrastructure and may, therefore, be restricted or off-limits. Especially in peacetime, countermeasures have to be balanced against potential adverse impacts on critical communication systems and economic loss.

Depending on the payload, e.g. biological toxins, chemical gases or explosives, it may be required to manoeuvre the UA out of range of friendly forces or civilians before the actual countermeasure comes into force. Therefore, 'traditional' C-UAS approaches which take effect on the spot need to be reviewed and should consider new approaches such as capturing aerial vehicles and neutralizing payloads.

Pre-emptive vs Reactive Countermeasures. Larger UAS require a significant amount of computer hardware, software and networks to operate. Therefore, the cyberspace domain may offer potential countermeasures capable of rendering the entire network and communications infrastructure of one or more unmanned systems inoperable. However, countermeasures in the cyberspace domain may require more than only a defensive posture. Pre-emptive and disguised placement of 'backdoors' in adverse computer systems may ensure access to these networks when required and it is probably the only way to be prepared and react promptly on an imminent UAS threat.

'A sole focus on the low, slow, and small end of the C-UAS spectrum covers only a fraction of current UAS technology and excludes most military applications.'

Dedicated legislation may also assist in defending against UAS in such a way that COTS 'drones' are required to transmit an identification and positioning signal comparable to the regular civilian air and maritime traffic. Some manufacturers already equip their drones voluntarily with transponders that provide this information on a separate and unencrypted radiofrequency. Of course, this will not prevent criminal or terroristic abuse of these systems, but if legislation were in place, any system not providing a transponder signal could be classified as potentially hostile.

The JAPCC Approach and Recommended Way Ahead

As outlined in this article, defending against UAS is not only a Force Protection or Air Defence issue, nor is it only about the aircraft or drone itself.

As of this year, the Joint Air Power Competence Centre established a Counter-UAS Focus Group (CUASFG) comprised of Subject Matter Experts from Intelligence, Surveillance, and Reconnaissance, Surface-Based Air and Missile Defence, Force Protection, Close Air Support and Air Interdiction, Electronic Warfare, Space Operations, Cyber Warfare and, of course, Unmanned Systems.

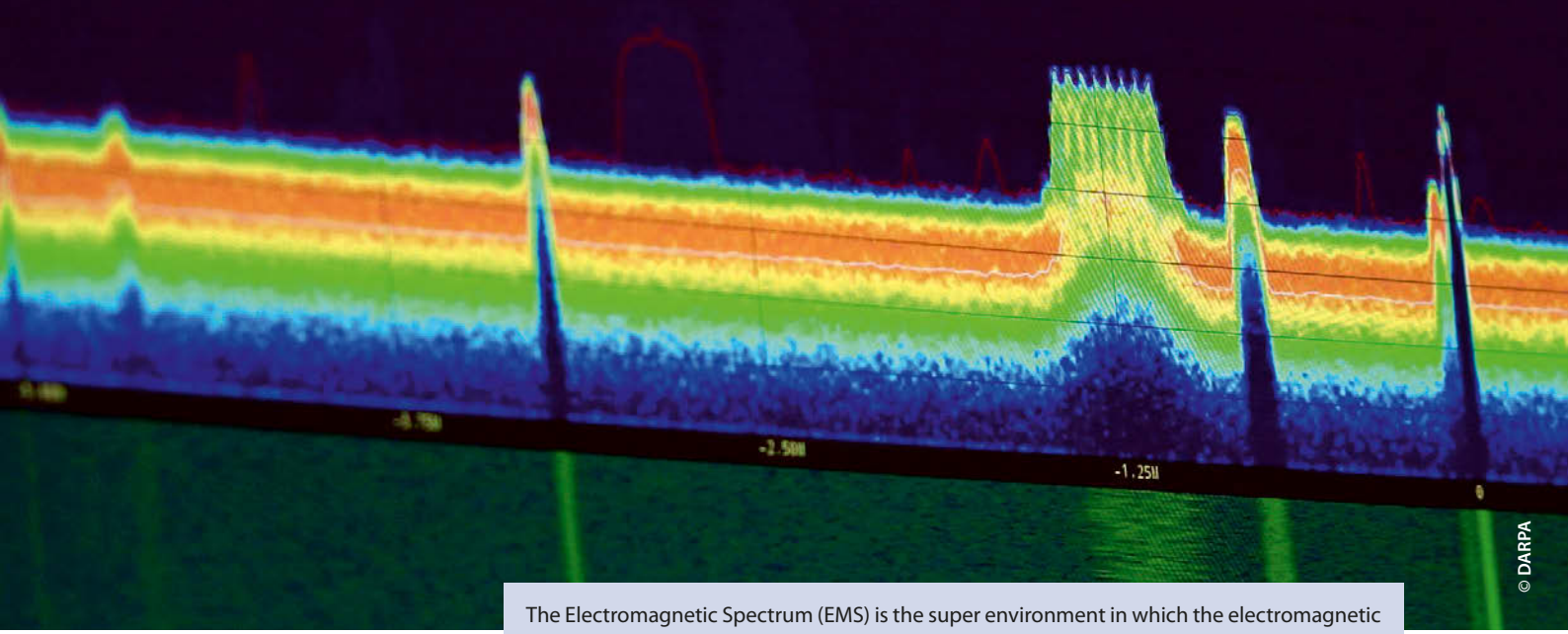
The JAPCC's CUASFG plans to liaise between the different subject matter areas and to provide cross-domain expertise with regard to the defence against the full spectrum of UAS. A comprehensive JAPCC study on C-UAS, to include a perspective from law enforcement agencies, is planned in the 2020 timeframe.

The JAPCC highly recommends NATO to establish a similar focus group to address the complex challenges of C-UAS comprehensively as current NATO doctrine and TTP need to be aligned across services and military branches to provide an effective C-UAS approach. ●

1. Koller Engineering GmbH, 'DroneGun', [Online]. Available: https://www.koller.engineering/dronegun/. [Accessed 15 Jul. 2019].
2. DroneShield, 'DroneGun Tactical', [Online]. Available: https://www.droneshield.com/dronegun-tactical. [Accessed 15 Jul. 2019].
3. IXI EW, 'DRONEKILLER', [Online]. Available: https://ixiew.com/page/. [Accessed 15 Jul. 2019].
4. SRC Inc., 'Silent Archer® Counter-UAS Technology', [Online]. Available: https://www.srcinc.com/what-we-do/counter-uas/silent-archer-counter-uas.html. [Accessed 15 Jul. 2019].
5. NATO Science & Technology Organization (STO), 'SCI-301-RTG Defeat of Low Slow and Small (LSS) Air Threats'.
6. NATO Science & Technology Organization (STO), 'SCI-ET-241 Development of a Counter Small UAS Analysis, Research and Demonstration Strategy', 2017.
7. NATO Industrial Advisory Group (NIAG), SG-170 (2013), SG-188 (2015), SG-200, SG-220 and SG-238 (2019).
8. The NATO Countering Unmanned Aircraft System Working Group (NATO C-UAS WG) has been formally established through the approval of the Countering Class I UAS practical framework, endorsed by NATO's Defence Ministers on their meeting on 13–14 Feb. 2019.
9. Raytheon Advanced Missile Systems, 'Defense at the speed of light', 24 Apr. 2019, [Online]. Available: https://www.raytheon.com/news/feature/defense-speed-light. [Accessed 16 Jul. 2019].
10. Dedrone, 'Worldwide Drone Incidents', [Online]. Available: https://www.dedrone.com/resources/incidents/all. [Accessed 16 Jul. 2019].
11. Federal Aviation Administration (FAA), 'UAS Sightings Report', 2014–2019, [Online]. Available: https://www.faa.gov/uas/resources/public_records/uas_sightings_report/. [Accessed 16 Jul. 2019].

Lieutenant Colonel André Haider

is the Joint Air Power Competence Centre's (JAPCC) Remotely Piloted Aircraft Systems Subject Matter Expert and the JAPCC's representative in the NATO Joint Capability Group Unmanned Aircraft Systems (JCGUAS). He joined the German Armed Forces in 1992 and is an artillery officer by trade with over fifteen years' experience in command & control and operational planning. He is also a trained United Nations Missions Observer and participated in several EU and NATO missions. His last post was Deputy Commander of the German Army's MLRS Rocket Artillery Battalion.



The Electromagnetic Spectrum (EMS) is the super environment in which the electromagnetic energy is operated, exploited, transmitted, received and sent in time and space like a blizzard.

The Electromagnetic Environment and the Global Commons

Are we Ready to Take the Fight to the Spectrum?

By Commander Ignacio Nieto, ESP N, Spanish Joint Command

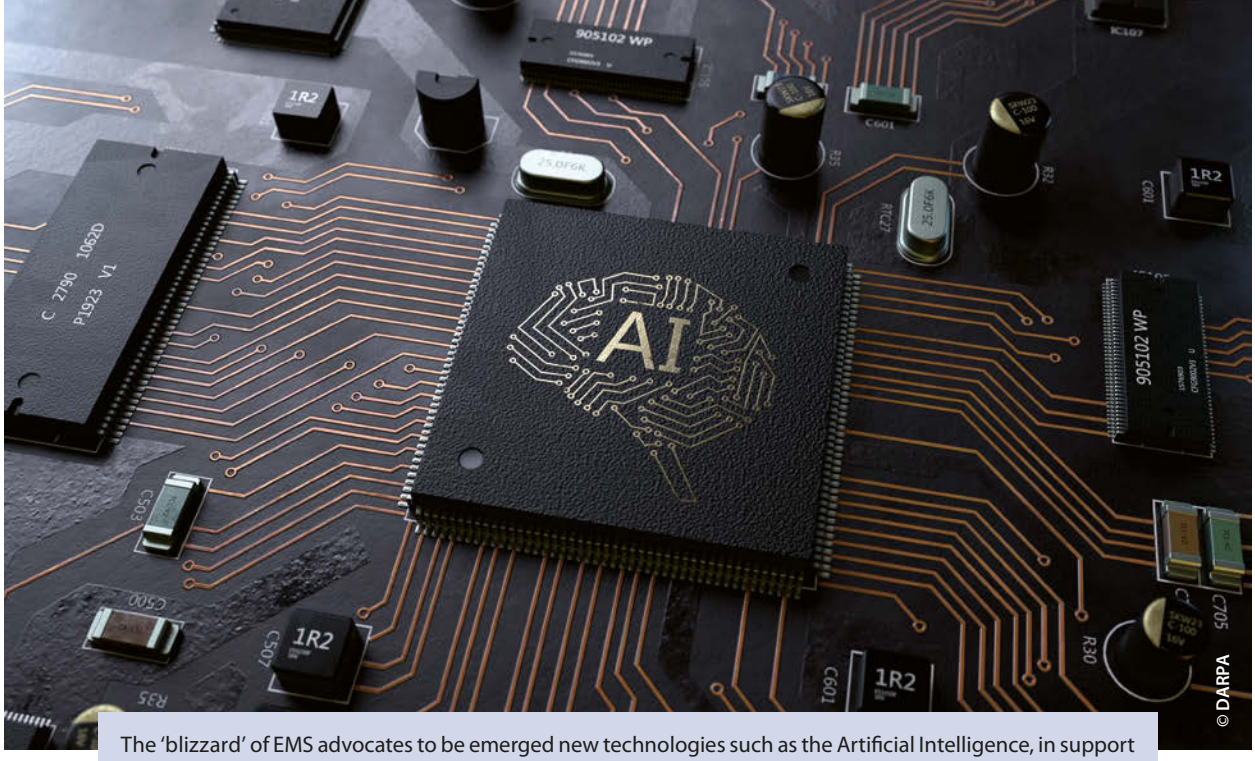
Introduction

The lessons learned from the conflicts in Ukraine and Syria provide a unique insight into the complexity of conducting military operations in a congested and contested Electro-Magnetic Spectrum (EMS). Even though the term 'spectrum' is well understood by the majority, it is the Electro-Magnetic Environment (EME) which best captures the message NATO tries to convey when it comes to operating, exploiting, transmitting and receiving, or sending electromagnetic energy in time and space. In this vein, NATO nations have agreed to define EME[1] as all of the electromagnetic phenomena occurring in a given place. Phenomena more than radio frequencies are better aligned with the essence of EME.

Freedom of movement and action in the EME have until recently been commonly accepted as a prerequisite for military operations. Success in modern military operations depends on making the most effective and efficient use and exploitation of the EME. NATO forces will operate within an increasingly complex and challenged EME[2] in the future, therefore NATO should articulate proper procedures for the complex and unexpected EME Environment of the future.

For a long time, NATO accomplished different lines of activity to ensure freedom of movement in the EME, where a loss of control will inevitably lead to mission failure. Many forums call for consideration of the spectrum as a battlefield since it has significant influence in the aptitudes and procedures of the other domains (land, maritime, air, cyberspace and cognitive[3]). These domains must inexorably work within the spectrum to accomplish their missions effectively.

Ukraine and Syria provide good examples and a greater understanding of this new form of conflict. It was unveiled as a new facet of armed conflict, which can be labelled as 'hybrid' or 'new generation' with EW as a



The 'blizzard' of EMS advocates to be emerged new technologies such as the Artificial Intelligence, in support of increasing the decision speed to the speed of light, and the particular 'snowflake' in the EMS is acquired.

key capability in paradigms. The rationale behind the Russian Federation's use of the EME in Ukraine and Syria was part of a larger strategy and one of the cornerstones of its Electronic Warfare (EW). Since the Georgian conflict (2008)[4] the Russian EW techniques are taking surprising turns when it comes to the electromagnetic battlefield.

This period saw the development of a new confrontation environment with the EME and its associated operations – Electro-Magnetic Operations (EMO). In 2007 NATO promulgated a concept[5] with the purpose to prepare for the transformation of the future electronic war. EMO was one of the cornerstones of this concept.

In the transformation document, NATO declared the EME as an operational environment, but not a domain. The EME cuts across all levels of warfare and must therefore be taken into account for the conduct and planning of every single operation. EMO models and exploits the EME, using it to attack or defend and includes the use of EME as supporting operations in all other operational environments (e.g. spectrum management and Position, Navigation & Time [PNT]). The challenge with NATO's transformation of future electronic war – was and is the communications strategy internally across the wider EMO community. Some communities (and individuals) have a high appreciation of the need to transform whereas other communities/capability groups are sticking to a ritual manifested approach to using the EMS.

The Technology

The advancement of technology is a guarantor of global economic growth and progress, both of which are directly related. The availability of technology increases and sustains a higher quality of life. That same progress continues at a frenetic pace and does not always allow us to adequately determine new weaknesses and vulnerabilities. Therefore, protection against these vulnerabilities may be lacking since it requires additional investment. In summary, as technology progresses without suitable precautions the vulnerabilities of our security systems increase in direct proportion.

A good example is the interconnectivity that the Global Positioning System, the infamous Global Navigation Satellite System (GNSS)[6] relies upon. GNSS, in addition to providing accurate positional data, also provides a global synchronized timing signal, crucial to the correct functioning for a multitude of modern technologies, this is a clear societal, commercial and military vulnerability.

In a get connected world, the future confrontations will likely take place in an urbanized environment rather than a traditional battlefield, complexity, congestion, degradation, deception, and confusion will likely characterize the future operating environment.

Smart grids are on the rise as well, which basically incorporate digital technology to establish direct communication between customer and user. The system utilizes software tools to increase the efficiency of overall electricity consumption. The key is to provide an effective grid steering to the volatile demands of electricity and ultimately improve energy efficiency across the regional power grid area.

Recently, the National Institute of Standards and Technology published a report describing Smart Grid dependency to the timing provided by the GNSS[7]. It should be noted, that the disruption, denial and deprivation of a GNSS signal is surprisingly simple to accomplish. The first stage analysis on many online search engines reveals procurement of short-range GNSS jammers for no more than EUR 60. Far from being a chimera, this situation is real and GNSS denial operations are with us right now.

Smart Grids are nothing more than an example of the type of vulnerability associated with the fast-paced advancement of technology. GNSS denial or exploitation is also an example of the consequences of not paying correct attention to the EME. From a strategic point of view, these vulnerabilities were also highlighted in the recently release report[8] by London economics about the potential loss of money due to GNSS disruption.

These vulnerabilities should encourage deep strategic, conceptual and doctrinal changes, by observing the latest and current conflicts and their subsequent developments. It may be necessary to build a new security and defence architecture in the face of changes to the strategic panorama that reveals so many important vulnerabilities, of which a large number are EME related.

Global Commons

Global Commons emerged as a major policy issue in the defence community when it comes to the safeguarding of national interests. Global Commons is not a new concept though as Admiral Alfred T. Mahan spoke in 1987 about the maritime environment being a Global Common[9]. Mahan envisioned the main mission of naval power to be keeping the maritime lines of commercial and own military passage open and to prevent access and use by adversary forces. At that time, maritime power was the driving force of the United States. For Mahan, that power arose from a process whereby all the social, political and military-economic forces were aligned and integrated.

The United Nations and the European Union define Global Commons as natural spaces beyond national jurisdictions[10]. Global Commons are spaces that need

to be used freely by the countries because the economy is heavily dependent on them. The laws pertaining to Global Commons are generally agreed upon, but, as a rule, they are not binding commitments or it is difficult to enforce them.

Ensuring free access to common spaces is one of the priorities of NATO nations. Without access, the social model could be compromised, because common spaces allow for guaranteed transit of goods, services and information. The high seas, international airspace, outer space, and cyberspace are modern global commons interlinked through the EME and are critical to the prosperity and security of the Alliance nations. Access to these domains is a military and economic necessity in today's world[11].

This is why NATO nations' national security strategies emphasize the importance of Global Commons and call for multilateralism to assure free access to them. Unfortunately, disruption of a Global Common is easy to perform.

NATO declared the four Global Commons[12]: air, space, maritime and cyber. Other entities choose 'the atmosphere' instead of 'air'. When it comes to translating the civilian term of atmosphere into the military sphere, NATO omitted an essential part of that Global Common, namely the EME. The same spectrum overlaps all other Global Commons; all utilize it and interconnect in a symbiotic manner.

The Global Commons are closely linked to globalization, which demands interconnectivity between them to provide high standards of living or societies. The disruption of a Global Common has impact on the other domains and can have economic, social and geopolitical consequences. The interactions between the four Global Commons do not multiply the complexity, but rather elevate it exponentially.

There is a strong debate supporting the inclusion of the EME as a Global Common, especially based on events in recent conflicts in Ukraine and Syria. The Russian Federation's exploitation of the spectrum puts NATO forces at a disadvantage in such congested and contested scenarios. The Global Commons enjoy the use of the EME without mitigating the vulnerabilities that access implies.

The EME has all the characteristics of being a Global Common. It is a global area with little regulation, it is vital for the economy and it is therefore necessary to protect it. The Global Commons are where the world trade occurs, denying their use would result in devastating consequences for the economy of any country.

Western countries are aware of the vulnerabilities of the Global Commons. For several years they have been trying multilaterally to maintain and guarantee access to the Global Commons. However, for some years, as witnessed most recently in Syria and Ukraine, the Russian Federation is increasingly able to affect the opposition forces freedom of movement in the EME. The Russian Federation's mastery of EW is putting some NATO Nations' armed forces at risk when it comes to the disruption of the Global Commons.

New Nature of Conflicts

Although it is not possible to predict with absolute certainty what the future will be like in terms of conflicts, it is extremely likely that Global Commons will play a central role in the geopolitical arena since the impact of a Global Common disruption on national economies is potentially catastrophic. Hybrid warfare bases its strength on exploiting vulnerabilities without escalating the crisis. The technology and its associated vulnerabilities have become more readily available, affordable and easy to exploit, not only to states but also non-state actors.

Problems arise when actions are taken (not necessarily military) to prevent persons, organizations or even nations from freely accessing Global Commons, normally by exploiting weaknesses in the security structures of western states using evolving technologies such as EW. In scenarios heavily influenced by adversaries' EMO, accomplishing a single military action may be difficult since the aggressions routinely occur below NATO's Article 5[13] threshold and the United Nations Security Council may be unable to agree on a Resolution to authorize the use of force.

Furthermore, the opportunity to employ EMO actions may provide added value in modern conflicts since it offers the option to respond with non-kinetic actions. As mentioned before, degrading or disrupting a Global Common may be easy to conduct utilizing EMO, but accurate or timely responses are frequently difficult to achieve since attribution can be difficult to prove. NATO needs to acknowledge that the EME rules the Global Commons and conceptualize and structure its capabilities towards this notion.

This scenario is already known and well described in the Allied Command Transformation (ACT) NATO Framework for Future Alliance Operations[14] (2018). In fact, EW superiority is a main recommendation for NATO forces if the organization wishes to remain fit for purpose through the foreseeable future.

Conclusions

The changing security environment is complex and challenging for NATO. Recent lessons identified the requirement to pay more attention to the EME. Economies are largely dependent on unobstructed access to Global Commons. In the era of globalization, there are many resources shared with the entire globe. Furthermore, the Global Commons contain an infinite potential with regard to the advancement of the biology and society of all life, hence they require absolute protection.

To cope with this threat, strong alliances and partnerships are key and more important than ever. NATO should continue to play its role in supporting nations to address these threats through enduring cooperation and collaboration.

NATO is finally placing a priority on efforts and effects in the EMO realm. These endeavours should enable NATO to offer the proper response to the current threats posed by the Russian Federation, especially in keeping the Global Commons open for all countries. NATO's continued prioritization on efforts and effects in the EMO will enable NATO nations to be ready to counter any aggression within a contested EME. ●

1. NATO Term definition.
2. Morrison, Brian, 'Is Red Air Meeting Your Needs?', The Journal of the JAPCC, Edition 17, Spring/Summer (2013): p. 63–67.
3. The cognitive/psychological domain is the most important as it consists of cognition and emotions which affect an individual's decision making (AJP-3.10 Ed A Ver1, p. 1–2).
4. Kofman, Michael, 'Russian Performance in the Russo-Georgian War Revisited'. Wars on the Rocks, Sep. 2018.
5. MCM 0142 Transformation concept for future NATO EW. Dated 23 Nov. 2007.
6. Global Navigation Satellite System (GNSS) refers to a constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers.
7. Goldstein, Allan. 'Time Distribution Alternatives for the Smart Grid Workshop Report': https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1500-12.pdf
8. Sadler, G., Flytkjær, R., Sabri, F., Herr, D., 'the economic impact on the UK of a disruption of the GNSS'. In LE London Economic. Available from UK Gov: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/619544/17.3254_Economic_impact_to_UK_of_a_disruption_to_GNSS_-_Full_Report.pdf
9. Mahan, Alfred T. 'Influence of Sea Power upon the history. 1660–1783'. Pelican. New York.
10. According to the World Conservation Strategy, a report on conservation published by the International Union for Conservation of Nature and Natural Resources (IUCN) in collaboration with UNESCO and with the support of the United Nations Environment Programme(UNEP) and the World Wildlife Fund (WWF): 'A commons is a tract of land or water owned or used jointly by the members of a community. The global commons includes those parts of the Earth's surface beyond national jurisdictions — notably the open ocean and the living resources found there — or held in common — notably the atmosphere.'
11. NATO ACT, Assured Access to Global Commons: https://www.act.nato.int/images/stories/events/2010/gc/aagc_finalreport.pdf
12. NATO ACT, Assured Access to Global Commons: https://www.act.nato.int/images/stories/events/2010/gc/aagc_finalreport.pdf
13. The principle of collective defence is enshrined in Article 5 of the Washington Treaty.
14. NATO ACT, Framework for Future Alliance Operations 2018: https://www.act.nato.int/images/stories/media/doclibrary/180514_ffao18-txt.pdf

Commander Ignacio Nieto

joined the Navy in 1989 and trained to become an Electronic Warfare specialist. After having served years in several EW postings he joined the Spanish SIGINT community posted either on board a SIGINT vessel or as an expert within the Naval Headquarters. In 2016 he joined the NATO SCHOOL, Oberammergau as the EW/SIGINT Subject Matter Expert (SME) both acting as such and as the course director of several courses, such as the Electromagnetic Operations Course, Joint EW Course or Suppression of Enemy Air Defences (SEAD) Course. Nowadays he is the head of the Electromagnetic Battlestaff Center in the Joint Operations Command in Spain.

NATO Training and Benefits of a Multi-Domain Approach to Targeting

By Adam T. Jux, BA, Civilian Targeting Consultant

Introduction

Since the early 2000's the western world, and particularly NATO, has been progressively scrutinized in their ability to conduct offensive operations. Targeting (the method by which we conduct offensive operations) has been developed and refined numerous times in our desire to be more transparent with our processes, to mitigate risk to civilians and civilian property and to ensure the legality of its delivery of ordnance[1]. Different and highly organized parties have criticized NATO in the past regarding the way modern warfare is conducted through protest[2], misrepresentation[3] or accusations of wrongdoing.[4] Media access to warzones in modern times means that the public have an informed view of conflicts from the comfort of their living rooms. While the military cannot control what is broadcast, nor the context in which it is given, it needs to be able to defend itself and its actions.

As modern weaponry develops, there is a constant need to review the way an organization trains and scrutinizes its own Tactics, Techniques and Procedures (TTPs) so that when real operations are being delivered, they are in line with the Laws of Armed Conflict (LOAC).[5] This is a challenge for any military force, whether it operates in isolation or as part of a coalition; not just for NATO.

To that end, NATO adopts a methodology that is repeatable, measurable and follows a specific structure so that its actions can be openly scrutinized and accusations refuted whenever they arise.

Current Structure and Doctrine

When technology changes over time, it is challenging for a military force to adapt their TTPs in order to maintain the principles of LOAC. These principles are

spelled out in many documents including the Joint Service Manual of the Law of Armed Conflict, which state that Distinction, Proportionality, Necessity and Humanity[6] are the basic principles that should be applied. These principles of international law are what NATO and many western nations adhere to in conducting offensive operations. Meeting those principles, with the added parameters of ever-changing and modernized weaponry, is an area that this article investigates and holds as a basis for the conduct of offensive operations.

Positive Identification (PID) of a target and distinguishing it as the enemy falls within the principle of Distinction where an armed body needs to ensure that a target is not civilian or civilian infrastructure. Many nations teach these principles, and the US Marine Corps, for example, highlights this in their basic training.[7]

In applying those principles it is easy to see how having eyes on a target, in order to ensure PID, adds to the complexity of forming a plan to engage an enemy when airspace and area is denied through air defence systems; it is complicated further when those targets are mobile, and their locations are undetermined. It is here that the synchronization and cohesion of all elements of a military force need to be aligned to maximize the effects of military planning to meet those LOAC principles. As weaponry has evolved, the range of weaponry and detection of Air Defence Systems, also known as Surface to Air Missiles (SAM), means that the ability to PID a target is increasingly difficult.

The Supreme Headquarters Allied Powers Europe (SHAPE) is responsible for the conduct of NATO Forces and does so through regular exercises to ensure that the alliance functions together and under the same principles. Given the multinational and joint character of Allied operations, coherence and interoperability between those national force contributions have to be enhanced. This includes the adoption of common doctrine, standards and procedures.[8] NATO issues Allied Joint Publications (AJP) to govern the allied approach to conducting offensive operations. AJP 3.9 is the allied doctrine for Joint Targeting and outlines the principles by which NATO targets the enemy during offensive operations. It has also evolved with the modernization of TTPs and modern day-weaponry, as the discussion above highlights.

Major exercises take place annually in every nation. NATO is no different as Exercise TRIDENT JUNCTURE 2018 (TRJE18) in Norway showed. The challenge for The Joint Warfare Centre (JWC) in Stavanger, Norway, charged with executing major exercises on behalf of SHAPE, including TRJE18, is the simulation of military assets and the tasking of them when it is the nations that supply these to the coalition.[9] The nations that make-up NATO have specialist equipment in their own right, many that are required to see beyond those denied areas mentioned above. The difficulty in simulating a national asset that isn't released to NATO, means that the Training Audience (TA) will struggle to know how to task or request support to conduct their offensive roles.

What is the Threat?

It would be reasonable to deduce that as nations advance their technology and weaponry, countries that see a threat emerging or intimidation would maintain an equal advancement in their arsenals to match that of their rivals. The natural instinct of self-protection will always prevail as will the drive to seek an advantage over one's opponent. In his journal article NATO's Next Act: How to Handle Russia and other Threats, the former Supreme Commander Allied Forces Europe (SACEUR) and Head of NATO, General Phillip Breedlove reflected on his time in that role from 2013–2016. He noted that 'the Alliance had shifted its focus to threats near the heart of Europe, namely Russian aggression … and recognize Russia as the enduring, global threat that it really represents.'[10] While NATO has more than one set of interests, it is clear that Russian is its primary focus.

Modern Day Weaponry

Russia advertised the S-400 Air Defence System as having a range of 380km in the booklet released on the system.[11] While the source could be considered a

little biased, its engagement range must be considered a worst-case scenario. 'Russia's potential to create "keep-out zones" or Anti-Access/Area Denial (A2AD) "bubbles" has become a source of concern in the West in recent years'[12], and is believed to be led from those operating ranges. While Russia has modernized its A2AD Air Defence Systems considerably in recent years, the article also suggests that 'the range of the S-400 has been generally accepted, without criticality', and disputes it as being much less. If the operating parameters are accepted by NATO, then this would be considered outside the range of modern-conventional weaponry.

The result of this is the need for aircraft to get within that A2AD detection ring to release weapons on the target. As mentioned above, the requirement to have PID of the target that you are releasing weapons onto for legal purposes increases the risk to aircrew, aircraft and the needless waste of expensive weapons. The counter development of allied military equipment has, therefore, to focus on stealth aircraft, stand-off weapons and supporting domains.

What is Multi-Domain?

The US Air Force Chief of Staff explained during a recent Tri-Lateral Steering Group (TSSG) Meeting that 'Multi-Domain is much more than the ability to work in multiple domains […]. It is also more than operations in one domain supporting or complimenting operations in another domain.' Following on from that, it was believed by the TSSG 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'.[13]

The viewpoint of the strategic meeting is the culmination of a Multi-Domain approach to counter future challenges to NATO and coalitions based on an expected threat, specifically asymmetric and hybrid tactics.

Lethal versus Non-Lethal Effects

It is difficult to make a comparison between lethal and non-lethal effects. Non-lethal could be considered a diverse collaboration of differing results that are specifically effective in their domain while limiting collateral damage. Conversely, lethal weapons are delivered through a precise practice that has a known effects radius and yield and expected destruction (effect). The incorporation of non-lethal into a lethal operational plan is difficult as it often requires a significantly longer time to see results from a non-lethal action, i.e. changing a mindset, influencing points of view, prompting a change in support. Assessing the effectiveness of an Information Operation (IO) is one of the greatest challenges facing military staff. Despite the evolution of IO doctrine and the refinement of supporting TTPs, the problem of IO assessment methodology is still unsolved.[14] The challenge in this is that the results are not always measurable. The results of IO are very rarely tangible; hence, the effect is extremely complicated to measure. This will continue to hinder the integration of these two means of offensive operation, but should not restrict their use. There is a clear specific requirement for both strategies, especially when seeking to adhere to the principles of the LOAC.

Cyber

Cyber is a domain which has been widely reported in news and articles and is a means of disrupting an enemy's systems or to influence an output that would go against its primary function from a great distance and by stealth. There were reports from the 2016 US Presidential Election, founded or not, that suggested that Russia had sought to influence the outcome of the election through boosting support for one candidate over another by increasing discord through social media. The application of offensive cyber, in support of counter A2AD operations, would seem to have the potential to have great effect on multiple aspects of an integrated (electronically connected) system. Many examples have been seen both recently and over the years. On 23 June 2019, the BBC reported of the United States targeting and disabling computer systems controlling rocket and missile launchers in

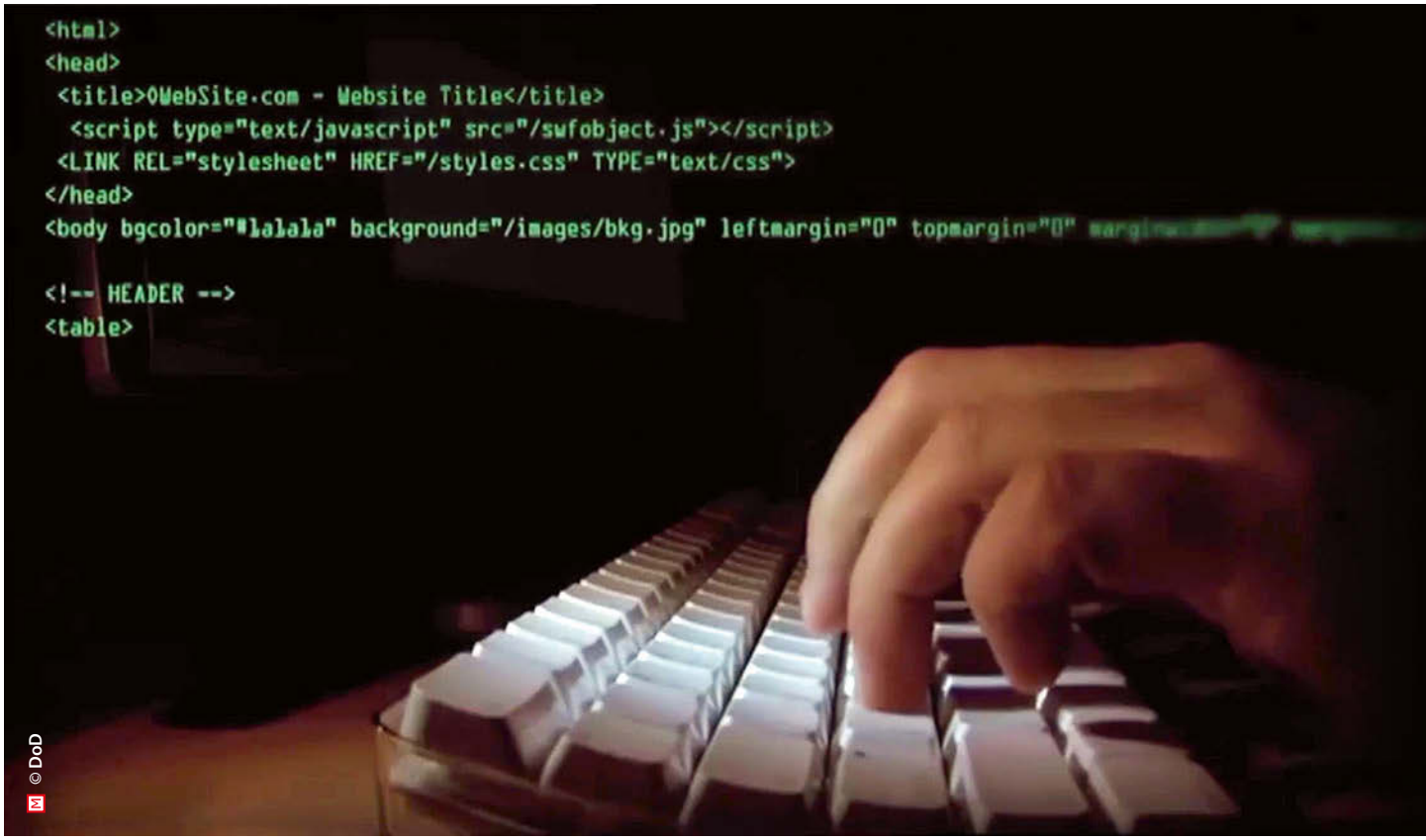
Iran.[15] More infamous is Operation Orchard[16] where the Israeli Air Force was tasked to destroy a nuclear processing plant in Deir-ez-Zor, Syria in 2007. It faced the challenge of eluding the highly capable Syrian Integrated Air Defence System and was ostensibly a complete success, despite a heightened level of surveillance by the Syrian air defence system, where the attacking aircraft were undetected. The success was reported in the article (Fulghum, et al. 2007) as being due to the synchronization of the air operation with both conventional electronic warfare jamming and a cyber operation that 'disrupted the data link' connecting the radar with the screens of the radar operators.

Influence

A non-traditional, but highly effective means of having an effect against the enemy is through differing means of influence. This is rarely directly at the target itself, but influencing things around it so that a second or third-order effect will act against one's intended target. False media reports can generate public unrest, which in turn, may affect an area and specifically personnel where an A2AD resides. The list of the means of influence is not exhaustive and economic, political, psychological and key leader engagement are also possible.

Offensive Capabilities in a Peer Conflict

The 'US Air Force currently envisages the F-22A Raptor as the primary weapon used to defeat these capable systems.'[17] It goes on to suggest that modern iterations of FA-18 and the Joint Strike Fighter (JSF), the newest procurement of fighter in numerous European countries, were not designed with the modern integrated Air Defence Systems in mind. If the West needed an avenue to counter such a threat, assuming that the operating parameters are correct, then only a Multi-Domain approach would allow a significant regaining of air superiority that the West has taken for granted in their most recent conflicts, e.g. Afghanistan, Iraq and Libya.



© US Air Force, Staff Sgt. J. D. Strong II

The integration of Multi-Domain effects and their synchronization at the joint level of any NATO force will need to be specifically structured if there is any hope of exploiting the potential effects of counter A2AD operations. The means of exercising NATO commands falls to JWC, which has evolved to better simulate a real-time conflict through the development of scenarios and investment in personnel in the white and red force areas. Major exercises take place every year, maintaining the operability of NATO as a fighting force, but in the best traditions of scrutiny and academic study, they focus on the process and highlight areas for improvement.

'As modern weaponry develops, there is a constant need to review the way an organization trains and scrutinizes its own Tactics, Techniques and Procedures …'

First-hand experience of exercising in NATO for the last six years has seen an excellent improvement in the way offensive operations have developed. It is accepted that simulation cannot substitute for real-life warfighting. There are just some things that cannot be simulated like the realism of following terrain contours to hide radar signature or the human thought process in avoiding threats from the cockpit; these are just challenges for the future development of training.

The ability to synchronize effects at the joint level is never an easy task, but mastering it is essential in today's modern times. Coupled with a headquarters command group that is committed to changing its internal structures, staffs need to embrace the means of incorporating and synchronizing the tools at their disposal. The most complex nature of this is the timelines that are required to have an effect. These differ significantly between non-lethal and lethal effects, so their synchronization to complement each other is difficult.

Conclusions

There are multiple examples of where a Multi-Domain approach is required within an integrated, A2AD region to have the required effect to penetrate into a denied area. There were few recommendations found of how to integrate these multiple domains, although suggestions of a specialized joint effects branch within headquarters was deemed a good start. This is even more important when the methodology used by a coalition or military force is so focussed on maintaining their legal aspects of targeting, PID, principles and collateral damage mitigation techniques.

Further study into this subject is required and it is almost as if this investigation has only touched on a much larger number of considerations that need to be

explored. A full understanding of how to combine multiple domains that contribute to offensive operations is particularly challenging. Where the current threat exists, and in the difficult environment of its integrated self-protection, further research can only help to develop a way forward in combating A2AD. ●

1. NATO Standardization Office (NSO), (2016) *AJP 3.9 Allied Joint Publication for Joint Targeting,* Edition A. Version 1, NSO.
2. No to NATO (2019), *About Us.* Reiner Braun. Available from https://www.no-to-nato.org/network-no-to-war-no-to-nato/about-us/ [accessed 11 Jul. 2019].
3. MacFarquhar, N. (2016) A Powerful Russian Weapon: The Spread of False Stories. The New York Times, 28 Aug. Available from https://www.nytimes.com/2016/08/29/world/europe/russia-sweden-disinformation.html [accessed 11 Jul. 2019].
4. BBC (2004) *'Editor Sacked over hoax photos'* BBC. Available from http://news.bbc.co.uk/2/hi/uk_news/politics/3716151.stm [accessed on 11 Jul. 2019].
5. International Committee of the Red Cross (ICRC), (2013), *Handbook on International Rules Governing Military Operations.* Geneva, ICRC.
6. Joint Doctrine and Concepts Centre, (2014) *JSP 383 Joint Service Publication for The Joint Service Manual of the Law of Armed Conflict,* 2004 Edition, UK Joint Doctrine and Concepts Centre.
7. United States Marine Corps *Law of War/Introduction to Rules of Engagement B130936 Student Handout.* Camp Barrett, Virginia 22134-5019: The Basic School Marine Corps Training Command. Available from https://www.trngcmd.marines.mil/Portals/207/Docs/TBS/B130936%20Law%20of%20War%20and%20Rules%200f%20Engagement.pdf [accessed 2 Oct. 2019].
8. Supreme Headquarters Allied Powers Europe (SHAPE) (2019) *Exercises and Training.* Mons: Public Affairs Office. Available from https://shape.nato.int/exercises [accessed 27 Jun. 2019].
9. Joint Warfare Centre (JWC) (2019) *Who We Are.* Stavanger: Public Affairs Office. Available from http://www.jwc.nato.int/index.php/organization/who-we-are [accessed 27 Jun. 2019].
10. Breedlove, P. M. (2016) NATO's Next Act: How to Handle Russia and Other Threats. *Foreign Affairs,* Vol. 95, No. 4 (Jul./Aug.), p. 96–105.
11. Nevskiy Bastion, (2014) *'Triumph S-400 anti-aircraft missile system'* – A.V. Karpenko Almaz-Antey GSKB.
12. Dalsjö, R., Berglund, C. and Jonsson M. (2019) Bursting the Bubble Russian A2/AD in the Baltic Sea Region: Capabilities, Countermeasures, and Implications. *Totalförsvarets forskningsinstitut (FOI) FOI-R-4651-SE, 9.*
13. Perkins, W. and Oliveri, A. (2018) Is NATO Today Sufficiently 'Joint' to Begin Discussions Regarding Multi-Domain Command and Control? *The Journal of the Joint Air Power Competence Centre (JAPCC),* Edition 26 (Spring/Summer 2018) p. 16–17. Available from https://www.japcc.org/wp-content/uploads/JAPCC_J26_screen.pdf [accessed 6 Jun. 2019].
14. Grohoski, D. C., Seybert, S. M., Romanych, M. J. (2003) Measures of Effectiveness in the Information Environment. *Military Intelligence Professional Bulletin,* Jul.–Sep. 2003, v. 29, no. 3.
15. BBC (2019) *US 'launched cyber-attack on Iran weapons systems'* BBC. Available from https://www.bbc.com/news/world-us-canada-48735097 [accessed on 27 Jun. 2019].
16. Fulghum, D. A., Wall, R. and Butler, A. (2007) *'Israel Shows Electronic Prowess'* Aviation Week, 2007, https://warsclerotic.com/2010/09/28/israel-shows-electronic-prowess/ [accessed on 27 Jun. 2019].
17. Almaz S-300P/PT/PS/PMU/PMU1/PMU2 Almaz-Antey, S-400 Triumf, SA-10/20/21 Grumble/Gargoyle – Technical Report APA-TR-2006-1201, by Dr. Carlo Kopp, AFAIAA, SMIEEE, Peng http://www.ausairpower.net/APA-Grumble-Gargoyle.html

Adam Jux

is a retired Royal Air Force Officer who also served in the Royal Australian Air Force and the Australian Army over his 27 years of military experience. He is a qualified targeteer having worked in the discipline for the last ten years, including on operations. He has instructed in targeting, collateral damage estimation and has mentored targeting at the Joint and Component levels. He recently consulted with the United Nations Institute for Disarmament Research (UNIDIR) and contributed to a research paper for the protection of civilians in urban conflict. He is currently working as a civilian targeteer for NATO's Joint Warfare Centre in Stavanger, Norway under contract for Comprehensive Training Solutions (CTS).

Hummingbird: © Paul Tessier/shutterstock; Background: © Free-Photos/pixabay

Small Nations in Joint Air Power

Protectorates or Valuable Partners?

By Lieutenant Colonel Petr Michenka, CZE AF, JAPCC

Introduction

NATO currently consists of 29 nations, soon to be 30. Each of these states has very individual national priorities, with different threat perceptions and existing defence capabilities. This article addresses the question of how small and resource-constrained countries can effectively fulfil their NATO commitments and contracts. The scope is constrained to the assessment of national contributions to the Joint Air Power (JAP) realm.

Smart Defence

The dissolution of the Warsaw Pact after the fall of the Iron Curtain created an illusion of safety, resulting in severe defence budget cuts over the recent decades. Nations throughout the Alliance either dramatically reduced investment in their own military capabilities or – in certain cases – they failed to retain some of them at all. Only a few of the biggest nations had enough resources to maintain robust and fully

Even small NATO members can accomplish their mission in an effective manner similar to Hummingbirds.
Small but efficient and effective!

comprehensive Air Forces. The economic crisis which struck in the first decade of the new millennium did nothing to improve this situation.

NATO Secretary-General, Anders Fogh Rasmussen proposed a solution for how to deal with austerity in a time of economic crisis. At the Munich Security Conference in 2011 he introduced the idea of 'Smart Defence'. This approach refers to 'ensuring greater security, for less money, by working together with more flexibility'.[1] The process, in which NATO acts as a facilitator for all allies, is based on three core components:

Prioritization: aiming at cost-effective alignment of national and NATO capabilities and priorities;

Specialization: encouraging allies to focus on what they do best and to coordinate their plans with other members;

Cooperation: by working together to allow states to develop capabilities that they would not be able to achieve on their own.[2]

Air Policing

One example of a Smart Defence project is the Air Policing mission. This peacetime collective defence operation includes the following elements: 'the use of the Air Surveillance and Control System (ASACS), Air Command and Control (Air C2) and appropriate air assets, so-called Quick Reaction Air (Intercept) or QRA(I) fast jets.'[3] The mission helps to cover the airspace over those NATO members who do not possess sufficient organic air surveillance and defence capabilities. Based on international arrangements, Albania and Montenegro are protected by Italy and Greece; Slovenia's airspace is covered by Italy and Hungary; Luxembourg signed a joint air policing agreement with Belgium and the Netherlands (within the BENELUX group). In case of the Baltic states (Latvia, Lithuania, Estonia) and Iceland, the Air Policing tasks are accomplished through periodic deployments of Alliance's Air Policing capabilities to the respective countries.

Baltic Air Policing

The NATO operation in the Baltic airspace typifies an Air Policing mission with a sound Smart Defence background. Joining the European Union (EU) and the Alliance in 2004, the former Baltic Soviet Union Republics have quickly become the symbols of all-embracing democratic transformation and successful economic as well as military integration into the Western community. From a military defence perspective, the topographical setting of the Baltic nations is highly disadvantageous. The only terrestrial access from the rest of NATO to Latvia, Lithuania and Estonia is possible through the so-called Suwalki Gap – a vulnerable, barely 104 km wide land corridor between Russia's Kaliningrad enclave and Belarus. The almost complete separation of the Baltic region from the rest of NATO, highlighted by Russia's regional military capabilities, makes the control of the airspace over the Baltic extremely difficult, but essential from a strategic perspective. Lack of indigenous air defence assets and associated infrastructure limits the Baltic states in fulfilling the obligations required by the NATO Defence Planning Process (NDPP), and creates military capability shortfalls in the region.[4]

Addressing this problem, the local governments and NATO planners have found a solution in a Smart Defence approach. They have entered into an agreement according to which safeguarding the integrity of the airspace over the Baltic Alliance members is the responsibility of coalition partners, while the local militaries provide Host Nation Support (HNS) capabilities. The Baltic states also have other ambitions to support NATO's Air Power, beyond just HNS establishments. For example, their Baltic Air Surveillance Network (BALTNET) incorporated into the Alliance NATINAMDS system acts as an important C2 element during NATO air operations over the region.

Solving the capability shortfalls in the Baltic states is a long-term project. It will require considerable financial resources, and for these resources to be invested into the right projects. However, allocating money is only one of the factors determining success. The Baltic states are amongst those states which do meet the 2 % Gross Domestic Product (GDP) threshold of defence spending.[5] Nevertheless, covering a complex spectrum of JAP operational requirements still remains unrealizable without intensive cooperation with NATO colleagues. The way forward is to build on the existing cooperation within the group of the three Baltic states and other NATO partners.[6] The role of NDPP as an intermediary and instrument for facilitation and coordination is crucial.

Icelandic Air Policing

Although not explicitly listed on the official Smart Defence list, Icelandic Air Policing (IAP) falls into the same category. What was originally a purely Air Policing mission gradually also gained a training and exercise dimension, within the frame of the Airborne Surveillance and Interception Capabilities to meet Iceland's Peacetime Preparedness Needs (ASICIPPN). The present concept makes the mission achievable even for contingents provided by coalition partners with limited resources. For example, the Czech Republic has repeatedly been able to put together small, but very effective contingents, consisting of less than 70 people and to send five (out of their 12 in total) Gripens to Iceland, in 2014, 2015 and 2016.[7] It is worth mentioning that in addition to these events the only Gripen squadron must also secure its routine tasks back home, including domestic QRA, regular training etc.

Although it does not have a standing military, Iceland is also actively involved in the ASICIPPN mission. In addition to providing HNS and Search and Rescue (SAR) services to the Allies, its Coast Guard units operate an Iceland Air Defence System, and provide reliable information about the air situation over the island. Air Traffic Control (ATC) operators have an opportunity to work with different coalition teams deployed there.[8]

NATO's presence on Iceland secures and guarantees the fundamental sovereignty of the island state, and prevents the violation of the integrity of NATO airspace. The added value of the ASICIPPN mission is, that Allied troops who are sent to Iceland gain an invaluable opportunity to train in an unfamiliar and very challenging environment.

Pooling and Sharing

NATO and EU have a lot in common. They are not only close geographically (22 out of 29 NATO nations are also members of the EU), but also politically – they share the same values, have similar strategic interests,

Sky: © KOKTARO/shutterstock; Gripen: © Milan Nykodym; Landscape: © Song_about_summer/shutterstock

and have to deal with similar security problems. Therefore, both organizations should cooperate in many areas – and the domain of Air Power is no exception.

The EU's main enabler of defence capability development and military cooperation is the European Defence Agency (EDA). As an institutional and legal structure of the EU, the EDA is very often involved in joint defence initiatives with NATO. This kind of collaboration remains a highly sensitive issue, especially for non-European Alliance members, who can often perceive common projects as a challenge to NATO's current functions. However, this perspective fails to take into account the context. NATO and the EU are not competitors, and their joint ventures must not be seen as a replacement of existing NATO security structures but rather as an important complement to them – this principle is anchored in the fundamental documents setting out NATO-EU cooperation, including the 2016 Joint Declaration on EU-NATO Cooperation, which explicitly states: 'The capabilities developed through the defence initiatives of the EU and NATO should remain coherent, complementary and interoperable.'

As mentioned above, the problems resulting from military budget cuts in NATO member countries were bridged using the Smart Defence projects. The EU has presented a similar scheme: Pooling & Sharing, which essentially has the same purpose – to save money and to make military collaboration more effective. The principal goals of the initiative ('to preserve and enhance national operational capabilities – with improved effect, sustainability, interoperability and cost efficiency as a result') were published in 2010.[9]

Air-to-Air Refuelling

Almost all European NATO countries suffer from chronic shortfalls in the area of Air-to-Air Refuelling (AAR), primarily caused by a lack of refuelling aircraft. It appears very challenging to reduce continuing over-dependence on United States (US) assets. Possible expansion of the existing fleets always come with enormous costs. This often means an unsolvable restriction – especially for small NATO members – if not tackled collectively. To solve the issue, the EDA was assigned to facilitate the project with three main goals: to optimize existing assets; to introduce the Airbus

A400M AAR capability; and to increase the Strategic Tanker Capability – the Multinational Multi Role Tanker Transport (MRTT) Fleet (MMF).[10] The involvement of small nations through the concept of Pooling & Sharing is best illustrated by the third pillar of the venture. The project was launched in 2016 with the signing of the Memorandum of Understanding between the Netherlands and Luxembourg. These states agreed to jointly purchase a fleet of Airbus A330 MRTT. In 2017, Germany and Norway joined the project, followed by Belgium in 2018 and the Czech Republic in 2019. The total number of aircraft in the shared fleet thus reached eight (with the possibility of further expansion to eleven). Taking into account a total number of roughly 60 tankers in Europe (excluding the United States, Canada and Turkey),[11] the programme implemented by the EDA represents a fairly significant contribution to Allied JAP.

The Netherlands, Belgium, Luxembourg, Norway, Czech Republic and Germany have addressed the AAR problem actively and responsibly. Through the Pooling & Sharing concept, they have obtained a relatively fast and cost-effective answer for how to satisfy all their training needs, how to maintain the currency of trained pilots, and how to support the operational deployment of their fighters. Moreover, the excess capacity of tankers can be offered to other Alliance members, which will help to diminish overall European AAR capability shortfall. However, the most important point is that these states were able to do this on their own, without creating any additional burden on larger coalition or Alliance partners.

Framework Nations Concept

At the 2014 NATO Summit in Wales, the Defence Ministers approved another initiative – Framework Nations Concept (FNC). This model provides a cooperation alternative to existing Smart Defence and Pooling & Sharing programmes. Similarly to the previously named constructs, the fundamental idea of the FNC is to bring the resources of individual participant parties together under a common organizational umbrella of some form. Involved countries are organized in multinational military groups – so-called clusters. Each of them is assembled around essential military elements established by a leading Framework Nation. Clusters consist of individual combat modules provided by together small and large states which coordinate their long-term contributions to the respective formations.[12] Several FNC groups, led by UK, Italy and Germany, have been formed in NATO so far.

Germany FNC

A structured top-down approach and linkage to the NDPP will ensure coordinated capacity development for FNC group around Germany with better results than the previously discussed Smart Defence or Pooling & Sharing constructs.[13] The initiative brings together 21 nations and is open to both NATO and non-NATO countries. The German model basically rests on two pillars. First, the 'Capability Clusters' element, in general follows the problems close to NATO Defence Planning Priorities, and synchronizes partners' capability development efforts. Second, the 'Larger Formations' cooperation element, seeks to strengthen NATO's pool of available follow-up forces.[14]

Under the first pillar, the joining states are jointly addressing existing capability gaps in four wider cluster groups – Command and Control/Support, Effects, Joint Intelligence, Surveillance and Reconnaissance (J-ISR), and Protection. These broad categories are further divided into 24 specific capability development clusters, such as Multinational Air Transport, Helicopter units, and Air C2 clusters.[15] Working in FNC clusters noticeably augments the NDPP's harmonization function, as the strengthening of defence capabilities of individual partner countries takes place in the context of the entire Alliance. The FNC structure ensures the coherence and complementarity of the goals pursued by the coworkers within the cluster, whilst the link to the NDPP guarantees the simultaneous fulfilment of NATO Capability Targets apportioned to individual nations.[16]

The second pillar, concentrates on standing up new larger combat formations. Within this part, a Multinational Air Group (MAG) was introduced as one of the proposals. The FNC will provide a tangible result for the Supreme Allied Commander Europe (SACEUR) in the form of a combat-ready group within Force Planning.[17]

It is planned to attach some MAG functions to FNC smaller partners, as well as to engage them through exercise and training. This is already happening now, namely in the form of regular MAGDAYs Joint Air exercises. Only during this year, two events have already taken place, with the participation of Czech, French, German, Hungarian and Polish Air Forces.[18]

The coordination between FNC and NDPP activities ensures alignment with NATO requirements. Working in an international environment significantly increases the interoperability of cooperating troops. The combat value of the entire MAG assembly is expected to be much higher than of their individual elements alone. Strengthening of combat capabilities particularly applies to small participating states. By joining the FNC project, the units from participating nations can complement missing capabilities and fully exploit their potential. Given to its association with the NDPP, the FNC profiles as one of the most effective forms of international military collaboration available.

Conclusion

Even small NATO members can accomplish their mission in an effective manner. They need consistently to synchronize their national defence planning with NDPP, and to focus their attention on Defence Planning Priorities. In order to maximize their contribution to Joint Air Power competence, the coalition members must pursue better efficiency of existing forces through the development of their availability, versatility and interoperability. Smart Defence, Pooling & Sharing and the Framework Nation Concept have proven to have a convincing synergistic effect on the capability development of their individual participants and also NATO as a whole. Therefore, the described models of collaboration should be considered as valid elements of effective NATO military transformation which enable even small nations to contribute effectively to NATO's three core tasks. ●

1. Rasmussen, A. F., 'Building security in an age of austerity', 2011. Online at: https://www.nato.int/cps/en/natolive/opinions_70400.htm [Accessed 30 Sep. 2019.]
2. NATO Public Diplomacy Division, 'NATO Encyclopedia', 2018. Online at: https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_2019_02/20190211_2018-nato-encyclopedia-eng.pdf [Accessed 30 Sep. 2019.]
3. NATO Allied Air Command, 'NATO Air Policing', 2019. Online at: https://ac.nato.int/page5931922/-nato-air-policing [Accessed 30 Sep. 2019.]
4. Harper, Sir Christopher, Lawrence T. and Sakkov S., 'Air Defence of the Baltic States', Tallinn, Estonia: International Centre for Defence and Security, 2018.
5. Stockholm International Peace Research Institute, 'Military expenditure by country as percentage of gross domestic product, 1988–2018', 2019. Online at: https://www.sipri.org/sites/default/files/Data%20for%20all%20countries%20from%201988%E2%80%932018%20as%20a%20share%20of%20GDP%20%28pdf%29.pdf [Accessed 30 Sep. 2019.]
6. Ibid. 4.
7. army.cz, 'Historie misí', 2019. Online at: http://www.mise.army.cz/historie-misi/default.htm [Accessed 30 Sep. 2019.]
8. Ibid. 3.
9. Germany/Sweden, Poolingandsharing, German-Swedish initiative Food for Thought, 2010. Online at: http://www.europarl.europa.eu/meetdocs/2009_2014/documents/sede/dv/sede260511deseinitiative_/sede260511deseinitiative_en.pdf [Accessed 30 Sep. 2019.]
10. European Defence Agency, 'Air-to-Air Refuelling', 2018. Online at: https://www.eda.europa.eu/what-we-do/activities/activities-search/air-to-air-refuelling [Accessed 30 Sep. 2019.]
11. Joint Air Power Competence Centre, 'Air-to-Air Refuelling Consolidation – An Update', 2014. Online at: http://www.japcc.org/wp-content/uploads/AAR-Consolidation_web.pdf [Accessed 30 Sep. 2019.]
12. Major, C. and Mölling, C., 'The Framework Nations Concept: Germany's Contribution to a Capable European Defence', 2014. Online at: https://www.swp-berlin.org/fileadmin/contents/products/comments/2014C52_mjr_mlg.pdf [Accessed 30 Sep. 2019.]
13. Ruiz Palmer, A., 'The Framework Nations' Concept and NATO: Game Changer for a new Strategic Era or Missed Opportunity?', 2016. Research Paper, No. 132.
14. Hagström Frisell, E. and Sjökvist, E., 'Military Cooperation Around Framework Nations: A European Solution to the Problem of Limited Defence Capabilities', 2019. Online at: https://www.foi.se/rest-api/report/FOI-R--4672--SE [Accessed 30 Sep. 2019].
15. Ibid. 14.
16. Ibid. 13.
17. NATO Allied Air Command, 'MAGDAYs: German Air Force hosts second live-fly exercise over Northern Sea with NATO Allies in 2019', 2019. Online at: https://ac.nato.int/archive/2019/magdays-german-air-force-hosts-second-livefly-over-northern-sea-with-nato-allies- [Accessed 30 Sep. 2019.]
18. Ibid. 17.

Lieutenant Colonel Petr Michenka

joined the Czechoslovak Air Force in 1990. He earned his pilot wings in 1996 and graduated from the Czech University of Defence in Brno with an Aviation and Rocketry Degree in 2001. He served as a fighter pilot with more than 1,500 flying hours (L-159 ALCA, J-39 Gripen). His operational experience includes several staff officer positions within the Czech Air Force HQ. From 2015 till 2018 he was the commander of 212th Tactical Squadron in Čáslav Air Base. In 2016 he was the Commander of 1st Czech Air Advisory Team in AFB Balad (Iraq).

In 2018 he joined the Assessment, Coordination & Engagement branch at the JAPCC in Kalkar.

The Strategic Value of Aircraft Carriers

Are They Worth the Investment?

By Commander Paolo Florentino, ITA N, JAPCC

Introduction

The political and military leaders of many seafaring nations with blue-water navies worldwide and strong maritime interests, in the effort to imagine the future of their military forces, could soon face the dilemma of whether or not to finance an aircraft carrier programme. While the United States Navy (US Navy), as the only global military power, has funded its fleet of 11 nuclear-powered aircraft carriers for fiscal year 2020, and the gas turbine engines of the United Kingdom's (UK) second new carrier started rotating gently for the first time at the end of 2018, France and Germany[1] are evaluating the opportunity to design and build an aircraft carrier to shape the European Union's role as a global security and peace force.

At the same time, in the challenging region of the Pacific Ocean, the Japanese government announced in November 2018 their intent to upgrade its two *Izumo*-class helicopters carriers to support the F-35B Lightning II stealth strike-fighter. Meanwhile, evidence suggests that the Chinese People's Liberation Army Navy (PLA(N)), has aspirations to become a true 'Blue Water Navy', and is now building its third aircraft carrier, which reportedly will be the first PLA(N) carrier equipped with a catapult system and built completely by indigenous shipyards.

Maritime Interest

The maritime arena, thanks to the immense patrimony that it preserves and the enormous amount of maritime traffic that passes through it, is the foundation of global trade. Modern oil and gas extraction techniques, growing ever more effective, together with the robust maritime transport (90 % of world goods travel by sea[2]) have, in fact, led the world-wide economy to be greatly influenced by the stability of the maritime environment. Shipping is the lifeblood of the global economy. Without marine shipping, intercontinental trade, the bulk transport of raw materials, and the import/export of affordable food and manufactured goods would simply not be possible. In this geo-political framework, it is clear that the economic prosperity and security of many countries are inextricably linked

to the sea, to the freedom of navigation and to the safeguarding of the sea lines of communication. Because of this link, crisis or conflicts anywhere on the planet affecting waterways and the freedom of navigation will create substantial repercussions around the world.

While many nations have brown-water or littoral naval capability, or Coast Guards to enforce the UN Convention on the Law of the Sea[3], these have limited reach and power. To ensure major maritime lines of communication, archipelagic sea lanes and straits remain open to free commerce and unimpeded by bordering nations, sometimes a stronger military deterrent force is required, and the core of this type of force is the ability to project power at sea. The most recognizable icon of maritime power since the end of World War Two has been the aircraft carrier.

Carriers

Based on the capabilities to support the launch and recovery of fixed-wing assets, aircraft carriers can be categorized into three groups:

The **CATOBAR** (Catapulted Assisted Taken Off Barrier Arrested Recovery), which includes the US Navy super-carriers of the *Nimitz* and *Ford* classes and the French carrier *Charles de Gaulle*. These units, equipped with nuclear propulsion and a flat-deck with a catapult launching system, ensure exceptional autonomy and represent fully-capable floating military airbases that can be deployed for long periods at great distances from their motherland. The US Navy operates with F-18 E/F and F-35C multi-role fighters on their super-carriers, plus a combination of EA-18G Airborne Electronic Attack (AEA), E-2D Airborne Early Warning (AEW) and C-2A transport aircraft. The deployable French Navy consists of the Dassault Rafale M multi-role fighter and the E-2C for AEW.

The **STOBAR** aircraft carriers (Short Take-Off Barrier Arrested Recovery), utilize conventional propulsion and were all launched from Ukrainian shipyards of the former Soviet Navy. They are currently in service within the Russian Navy *(Admiral Kuznetsov)* operating Sukhoi Su-33 and MiG29K, the Chinese People's Liberation Army Navy *(Liaoning)* flying the Shenyang J-15, and the Indian Navy *(INS Vikramaditya)* flying the MiG29K.

The **STOVL** carriers (Short Take-Off and Vertical Landing), can base their air components on specific aircrafts with STOVL capabilities such as the AV-8B Plus, and more recently the F-35B. These 'light' aircraft carriers, or amphibious 'through-deck' units capable to support fixed-wing assets operations, are equipped with conventional propulsion and are in use in major NATO Navies, namely the Royal UK Navy *(HMS Queen Elizabeth),* the Italian Navy *(ITS Cavour, ITS Garibaldi),* the Spanish Navy *(SPS Juan Carlos I),* along with the US Marine Corps' Landing Helicopter Dock (LHD) *Wasp* and Landing Helicopter Assault (LHA) *America* Class units.

The overall Air Power that an aircraft carrier brings to the operational area is not only limited to the tremendous capabilities that the fixed-wing assets can deliver, it includes the capabilities of the organic rotary-wing assets and of the embarked ballistics and cruise missiles available, from the escort and support ships that sail with the carrier as part of a Carrier Strike Group (CSG).

An aircraft carrier is considered the most valuable sea-based asset, and offers an incomparable military instrument with its ability to project tactical Air Power over long distances, including Air Interdiction, Anti-Surface Warfare (ASuW), offensive and defensive Counter-Air, AEA and AEW.

The freedom of navigation[4] and overflight in the international waters, the right of innocent passage of the territorial waters and the right of transit passage of international straits all guaranteed in the UNCLOS, means that a CSG has worldwide mobility. It has potential access to almost any area of latent crisis, considering that the earth is covered mostly by water and that a major portion of the population lives within 100 miles of the sea, and capability to arrive on station relatively quickly and remain in the area. As a floating airbase, an aircraft carrier combines operational flexibility and speed of intervention to the projection force of a relevant maritime nation, freeing it from the problems and political compromises linked to the diplomatic authorizations necessary to operate from a land airport abroad, and the clearances to overfly other countries' airspace (assuming the country isn't landlocked).

The world's seas are vast. Maritime forces therefore have developed long-range capabilities and the capacity for a constant presence at a particular location for a prolonged period with limited logistic dependence. This endurance can be further extended by their capability for replenishment at sea. A carrier is therefore able to operate independently for prolonged periods, even in the absence of a host nation, and to cover great distances. It is an autonomous microcosm, as it has everything needed to operate internally, from food to fuel, from ordnance to supplies, and is therefore capable to express the maximum of its capabilities from the very first day of intervention.

The speed of advancement of a CSG, however, is limited (approximately few hundred nautical miles a day) and can be adversely affected by weather conditions, making movements relatively time-consuming. This requires early or forward deployment of maritime forces, and mobility and access in the maritime domain make this possible. The limited speed of advance over water is, however, relative; naval forces can normally move more quickly over long distances than large land forces, and this aspect contributes to the effect and power of a CSG significantly.

Moreover, operating from an advanced mobile airbase limits the impact of fatigue on personnel and aircraft, due to the close proximity to the affected area which reduces overall flight times. Operations can be conducted with maximum safety, as a warship underway is far less vulnerable to commando's incursions and terrorist attacks compared to a fixed airport ashore in a country near the area of crisis. Furthermore, sea-based aircraft missions, with the carrier cruising beyond the visual horizon, allow operations out of the view of prying eyes which enables the element of surprise, benefits the safety of the crews and aircraft, and ensures covertness. An aircraft carrier can provide the only military airbase facility employable during the initial phases of an operation, able to launch and recover friendly air assets, as shown during the early phases of operation in Afghanistan in 2001[5].

However, an aircraft carrier is even more than just a military platform; it is a tremendous diplomatic tool, able to exert influence by its mere presence in an area,

and to deliver strategic political messages. The type of influence is exceptionally flexible. A CSG can be used as a threat, but can also serve to strengthen alliances and forge coalitions. Influence can be increased easily, or forces can be withdrawn with a lower impact on the public opinion. From a political perspective, a CSG constitutes a highly adaptable instrument of power to control a threat in an early stage, allowing crises prevention and, if necessary, at considerable distances from home. It allows the political leaders to finely calibrate diplomatic or military actions to optimize the management of a crisis or conflict. The contemporary presence of three US nuclear aircraft carriers conducting joint operations near the coast of the Korean peninsula in November 2017[6], was a clear show of force from the White House against the aggressive posture of the North Korean government. On 18 November 2015, the aircraft carrier *Charles de Gaulle* left its homeport of Toulon heading towards the eastern Mediterranean to support the bombing operations carried out by the international coalition against the Islamic State of Iraq and the Levant (ISIL) in Syria. If the decision was made before the 13 November 2015 terrorist attacks in Paris, it was surely accelerated by the events, stemming from the strong willingness of the French government to prosecute global terrorist organizations with their best military assets.

As emphasized by the former United States of America Secretary of the Navy Ray Mabus, the CSGs 'get there sooner, stay there longer, bring everything [they] need with [them] and don't have to ask anyone's permission. [They] provide our nation's leaders with options in times of crisis'[7].

With an expected operational service-life of approximately 50 years, an aircraft carrier is an asset that requires a lot of resources for the continued and proper maintenance, and for the constant training to allow the ships', decks' and air-wings' crews to operate in a safe, coordinated and proficient way. The accidents that occurred on-board the *Kuznetsov* during the operational deployment in the East Mediterranean sea during the Syrian war at the end of 2016 (they lost one MiG-29K and one Su-33 in less than three weeks[8]) show, that naval aviation is an inherently dangerous business, and that properly funded and proficient maintenance and training are required for safe and effective air operations at sea.

The awareness of the importance of training for naval aviation crews has led the UK Navy to ask for help from the US Navy and Marine Corps to re-gain and maintain the skills it needs to operate aircraft carriers due to the entry into service of the *HMS Queen Elizabeth*. For this, UK aircrew and flight-deck personnel have been trained on-board US carriers.[9] At the same time, the Italian Navy is carrying out the work of adapting the *ITS Cavour* to the F-35B standards, planning to achieve Initial Operational Capability (IOC) by the end of 2023 with 8 F-35Bs and 12 navy pilots.

Conclusion

An operationally outstanding asset, capable of being effectively integrated into a combined multinational campaign, the aircraft carrier is sometimes the only instrument in the event of a crisis capable of intervening in the initial phase of an operation, thanks to the mobility and access granted to the maritime forces and the possibility to be prepositioned. Its mere presence in the area establishes a credible naval and air presence in support of national interests and political objectives.

A carrier is representative of the relevance of the country that owns it, a pillar of the power projection capabilities and maximum expression of the nation's naval diplomacy, as well as tangible proof of the country's technological proficiencies.

In summary, an aircraft carrier is a military tool of tremendous operational capabilities, which can provide the military and political leadership of a relevant maritime country with credible options and solutions for crisis management. While expensive to buy and operate, it may be ultimately less expensive and far more flexible (both militarily and politically) than deploying and sustaining land-based air assets to an available friendly host nation, and therefore well worth the investment. ●

1. https://ukdefencejournal.org.uk/germany-proposes-european-aircraft-carrier/
2. http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade
3. United Nations Convention on the Law of the Sea (UNCLOS), 1982.
4. Ibid.
5. Gregory Bereiter, The US Navy in Operation Enduring Freedom, Naval History & Heritage Command, 2016. https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/u/us-navy-operation-enduring-freedom-2001-2002.html
6. https://thediplomat.com/2017/10/what-3-us-supercarriers-in-the-asia-pacific-means-for-north-korea/
7. US Navy (2016). Naval Aviation Vision 2016–2025. http://www.nae.navy.mil
8. https://news.usni.org/2016/12/05/second-russian-carrier-based-fighter-crashes-pilot-safe
9. https://www.royalnavy.mod.uk/news-and-latest-activity/news/2017/august/15/170815-carrier-strike-exercise-ends-ahead-of-hms-queen-elizabeth-arrival
https://www.bbc.co.uk/news/resources/idt-sh/UK_aircraft_carriers

Commander Paolo Florentino

Graduated from the Italian Naval Academy in 1991, was trained by the US Navy, and qualified as Naval Aviator in 1994. He flew ASW/ASuW Helicopters such as AB212, SH3D and EH101. He had appointments as Flight Commander on several warships, staff officer of the Italian Fleet Air Arm, Commanding Officer of the 2nd Helicopter Squadron and later of the 3rd Helicopter Squadron. As a Navy line officer he commanded the ITS Tirso. He participated in Operation Enduring Freedom as Navy Liaison Officer to ComUSNavCent, and has been awarded for NATO Operation Sharp Guard and the Italian operations related to the Albania crisis and supporting UNIFIL. Since August 2016 he serves the JAPCC as Subject Matter Area for Maritime Air/Embarked Rotary Wing.


JAPCC invites you to attend the
2020 | AIR AND SPACE POWER CONFERENCE
Leveraging Emerging Technologies in Support of NATO Air & Space Power
6–8 October 2020, Essen, Germany
Joint Air Power Competence Centre
JAPCC
Joint Air Power Competence Centre
Soldiers: © US Army, Sgt. Steven Lewis;
F-35: © Lockheed Martin;
Earth: © Johan Swanepoel/shutterstock;
Clouds: © prapann/shutterstock;
Ship: © US Navy, MC 2nd Class Corbin J. Shea
www.japcc.org/conference

European Air Transport Command

Developing Air Mobility for Europe or How to Undertake an Audacious Idea to Tackle Efficiency!

By Brigadier General Francesco Saverio Agresti, Deputy Commander EATC

Introduction

When the European Air Transport Command (EATC) was established in 2010, it was the most suitable solution for some European nations in search of a trustworthy and flexible solution to optimize the use of scarce air transport resources and to face harsh operational challenges. Since then, EATC evolved quickly, growing from the initial four founding nations to the current seven-member nations. EATC has certainly become the major provider of military-air transport in Europe. The realization that the combination of national assets in this respect would form such a successful unit was most welcome. Pool and sharing of air transport capacities, operational experience and expertise, as well as the technical know-how, was the key to success. This formula allows EATC to effectively use the transferred national fleets. Additionally it supports the integration of different systems and capabilities into the EATC fleet and currently the most effective integration of the new-generation air-transport capabilities such as the A400M or the A330 MRTT.

What is the Added Value of EATC?

In the last decade, the rapid deployment of troops or the rapid delivery of goods over long distances in time-sensitive operations was decisive to the success of these operations. Air mobility is a key factor in swift military power projection and is becoming increasingly important in today's security environment. The fact that the smart use of airlift assets can accelerate the crisis-to-employment timelines overcoming any geographical or distance challenge, places a fundamental premium on the mobility-airlift system. This simple statement gives an idea of the operational, if not strategic, relevance of air transport for each one of the EATC member nations and a clear idea of what these same nations decided to forge together. The payback from the venture EATC to the member nations was beyond expectations.

© Courtesy Photo

What Does EATC Offer that a National Alternative Would Not?

Despite many challenges from somewhat elderly fleets to a new generation transport fleet, the operational record of EATC is impressive. With an assigned fleet totalling about 170 transport airframes of all sizes and 23 different types, EATC commands and controls between 8,500 and 9,500 missions per year. EATC effectively supports its member nations' military transport needs within Europe and overseas. The support provided during the execution phases of major operations in *Barkhane, Resolute Support Mission, Minusma and Counter Daesh* are merely a few examples.

In a multinational framework like EATC, managing air mobility missions is complex and complicated. EATC covers the entire package of the air mobility strands of work. This includes: managing multinational requests, coordinating diplomatic clearances and optimizing the use of a high number of different aircraft types. But it is also taking into account EATC, international and national military regulations. Despite many challenges, EATC has proven to be actually able to quickly and effectively deploy and redeploy forces anywhere in the world. This ability is the essence of the air mobility actors. This is EATC!

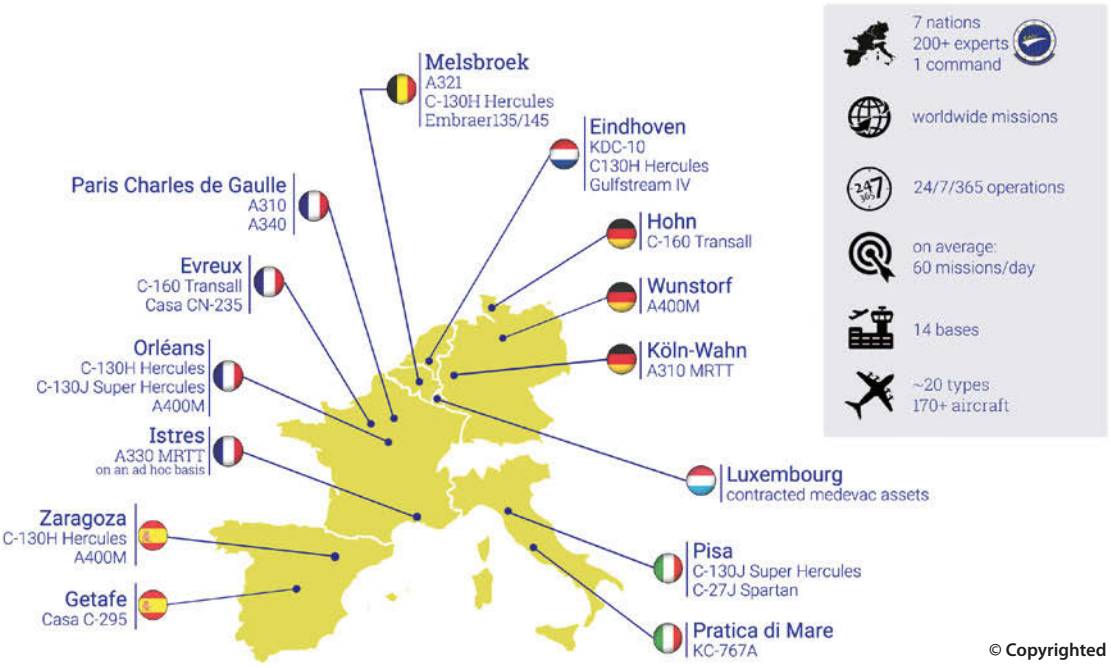
However, in a multinational setting the capability to deploy effectively and efficiently requires more than a high level of hardware, skills and preparation. If the nations wish to act together, they also need a common understanding of the air mobility business. In technical terms, this means an adaptation of common Tactics, Technics and Procedures (TTP), multinational training and a common military operational culture. To that end, EATC is striving to refine the spectrum of common standards. We advocate for partnership capacity training programmes in various domains (multinational ground handling school, cross-maintenance framework, A400M package leader course). This cooperative effort does not only include EATC member nations, but also other European Union (EU) member states and North Atlantic Treaty Organization (NATO) allies. The operational success is dependent on common standards and multinational training. This improves the ability to conduct day-to-day operations in joint and coalition environments. And this is what EATC excels in!

In short why EATC is so important? Because military and operational success often depends on the 'how much' and the 'how quickly', on pooling and sharing of assets and capabilities. EATC is a lighthouse project in terms of true multinational cooperation and integration in military air mobility!

What does EATC offer to our member nations that a national alternative would not offer? Reduction in financial, organizational and human resources, a readily available means to overcome national capability shortfalls, reduction of the logistical footprint, efficient air mobility solutions, and inherent flexibility are just a few examples.

How Does EATC Raise the Stakes of Air Mobility in Future?

The EATC is already in the process of a major renewal and growth of the assigned fleet and a much larger capability portfolio will be available in the future. By 2025, the EATC nations will be the main providers in Europe of a modern transport fleet with more than 100 A400M, 30 C130J, and more than 20 A330 Multi Role Tanker Transport (MRTT) and KC-767. In particular, the expected availability of this amount of A400Ms will greatly enhance EATC's overall strategic and tactical capabilities. In fact, EATC will have an unprecedented capacity to carry out extensive operations even on unpaved airstrips, carrying, in a single asset, up to 37 tons of payload which may include armoured combat vehicles, self-propelled artillery, support vehicles or helicopters. The entering into service of these new platforms and the planned acquisition of greater capacities brings along a larger spectrum of options, as well as additional conceptual challenges and opportunities. Harmonizing technical provisions, operational procedures and employment solutions will be key for an effective pooling and sharing of these new significant capabilities. EATC intends to harmonize and standardize the employment of these new aircraft. It is a holistic and wide-ranging approach where



a mere standardization of the operational TTPs will not be sufficient. Technical solutions adopted aboard the aircraft, aircrew manuals and training, and engineers' and ground handlers' procedures should also be standardized. The challenge is significant. A firm commitment and support from all the parties involved (member nations' air forces, affected industries and concerned organizations) will be required.

From an operational perspective, the availability of a larger fleet and a more capable aircraft in the next few years will offer great opportunities and increased efficiency. The objective is evident, however, at the moment, given the resources available and the existing constraints, EATC manages to satisfy the member nations' basic operational needs. Moving forward we seek to be able to operate more cost-effectively. EATC has worked out an intriguing but audacious idea to tackle efficiency. The established modus operandi foresees that EATC is only acting when an air transport mission has been requested. EATC, however, assumes a more proactive stance and intends to set up pre-scheduled regular cargo flights to the most common destinations or to support an ongoing operation.

This is known as the 'shuttle system'. The development of the concept started in September 2017, but was delayed due to the low availability of airframes and extensive limitations. With the new capabilities becoming available, this system can be significantly improved. It will be made more reliable, more robust and even … more multinational. The final goal will be to set up a worldwide transport network. Selected big logistical hubs in the member nations will be connected to each other and will be linked through regular multinational cargo flights with the most critical destinations around the world. This requires adaptive rules and regulations, increased freedom of movement and higher flexibility. However, the gain this option would offer in terms of improved pooling and sharing and therefore better efficiency is huge and worth the effort.

The idea is the so-called 'smart co-basing concept'. It is a planned network of permanent and temporary bases (flexible system). Cargo will be routinely transported through the EATC air network, while air and ground combat units are moved over global distances in a matter of a few days or even hours. Indeed, the execution of integrated operations requires a joint force capable of swift force projection around the world relying upon a global logistics and transportation network. This means that, without air mobility, all strategic, operational, tactical and logistical concepts may be at risk. On the other hand, if military air logisticians expect a higher degree of flexibility in Air Power when it comes to rapid movement requirements for contingency operations, natural disaster relief deployments or medical evacuations, the EATC is already in the process of developing such a network to fulfil this requirement.

Future developments and future challenges, another relevant aspect, will impact the widespread introduction of modern communications and sensor technology throughout the air forces. The developing

communication environment has fully encompassed the EATC transferred fleet by including, for instance, Satellite Communications (SATCOM). EATC's command and control processes will evolve and require quick and effective adaptation to new technologies. Simultaneously, the realistic aircrew training will definitively shift towards a digitized battlefield. EATC subject matter experts are already tackling the subject and the opportunities for the EATC to grasp.

Looking ahead and considering the new data flow management environment, EATC member nations connect to a single EATC operational cloud envisaging a higher level of information sharing. In turn, this achievement actually brings remarkable operational gains. Considering that the new platforms, like the A330 MRTT and the A400M are not just multi-role, but indeed multi-mission assets designed to globally support a multi-mission air and joint force, one may only imagine the importance that a shared mission management data system guarantees in terms of flexibility. The multi-role and multi-mission capabilities of these aircraft offer, by definition, various airlift options for supporting ground manoeuvres or forward air bases and airfields. They can provide, almost simultaneously, aeromedical evacuation capability, intra-theatre tactical airlift or inter-theatre strategic flight and air-to-air refuelling options. In light of this, effective integration, coordination and synchronization of inter-theatre and intra-theatre air-mobility operations becomes a new crucial capability. Swift transfer of tactical control or the ability to redirect an A400M to an air-refuelling area, where unexpected tactical support is needed, will be key requirements for exploiting the full potential of the new platforms.

Conclusion

Anticipating a tough and uncertain security landscape, air mobility is and will remain a critical future pillar of air and military power. Large-scale, theatre-to-theatre movements are to be considered as an integral and unavoidable part of the planning process and need to be approached in a comprehensive manner. A high level of preparation, integration and common understanding will be a basic requirement to deliver the right effects, at the right place and at the right time in a synchronized, connected and multinational environment.

From its inception, less than ten years ago, the EATC has quickly become a catalyst for Air Power in the spectrum of air mobility. Today, it is a major actor in Europe and it will become the main air mobility provider within the next decade. Currently at the service of seven-member nations, the EATC will continue to develop its ability to cooperate together, to foster interoperability and to set up a more reliable and robust operational mechanisms together with more proactive and responsive command and control options.

The current status is good, but the future looks absolutely bright. EATC will keep on building a common understanding of what is at stake and what great opportunities lie ahead. EATC will generate within Europe a true common operational culture.

Brigadier General Francesco Saverio Agresti

joined the ITAF in 1984. He was stationed for most of his operational flying career in Northern Italy and started flying the Fiat G-91, followed by the AM-X in both, the Fighter-Bomber and RECCE role. Brigadier General Agresti participated in NATO operations in Bosnia-Herzegovina and Operation 'Allied Force' in Kosovo. In the following years he attended the Advanced Command and Staff Course in the UK, held responsibilities in the Flight Safety Inspectorate in Rome, commanded the 32 Wing in Amendola (2007–2009), and headed training & exercise, standardization and then operational planning in the Air Forces Command in Rome. More recently, Brigadier General Agresti commanded the ITAF Joint Air Task Force in Afghanistan (2014) and the 1st Air Brigade Special Operations in Cervia (2014–2017). Since November 2017, he has been the EATC Deputy Commander/ Head of Operations.


© JAPCC

The JAPCC Annual Conference 2019

Shaping NATO for Multi-Domain Operations of the Future

The Joint Air Power Competence Centre hosted its 2019 Joint Air & Space Power Conference from 8–10 October in Essen, Germany. This year's theme was Multi-Domain Operations, or MDO. An extremely productive discourse traced the evolution of MDO from the increasingly dynamic strategic climate and technological challenges necessitating this more advanced form of warfighting to challenges NATO will face in implementing the concept.

This successful event would not have been possible without the tremendous support of our nine sponsors and the participation of over 320 experts representing NATO, EU, Partnership for Peace, and partners from as far away as Japan and Chile. Moreover, the input from more than 60 General/Flag Officers and senior civilian leaders, coupled with the contributions from research agencies and academia, combined to create an incredible opportunity for attendees. Each day consisted of a senior leader address and two expert panels where diversity of thought and real-world experience fuelled the effort to tackle one of NATO's biggest challenges.

Several themes permeated conference discussion, the first of which was the difficulty in defining MDO, with questions such as: 'What constitutes a domain?' and, 'Is MDO an evolution or a revolution in warfare?' The granularity of this discussion will be instrumental as the JAPCC attempts to craft a doctrinal definition for future NATO use. What was widely agreed upon is that tomorrow's war will be unlike anything we have seen, and the need to ensure freedom of operation in space and cyberspace, while managing the effects of the electromagnetic spectrum on all domains will be at the fore. NATO has come to recognize the primacy of space as a domain that it cannot win without.

Yet another theme emerging from the conference was the need for both cultural and institutional change throughout NATO. The essence of MDO is speed and confronting the adversary with more problem sets than he can manage at once, and this will require increased reliance on mission command and ensuring authorities are pushed down to the lowest practical level. It will require a new way of thinking, in which senior leaders must leverage the technological prowess of younger generations and ensure they are endowed with cross-domain experience. MDO demands that we harness the power of machine learning and artificial intelligence for military operations, all while ensuring a human remains on, not in the loop, to allow for maximum speed to be synchronized with human ethical and rational analysis.

JAPCC Director General Jeff Harrigian concluded the conference by reminding us that MDO cannot wait years or decades for development, instead we must start making progress now, and not be afraid to 'fail fast' in the pursuit of learning. A detailed report on the entire event is soon to be published as *Conference Proceedings* on the JAPCC website, along with information about next year's conference: **Leveraging Emerging Technologies in Support of NATO Air and Space Power.**

The JAPCC hosts 6th Annual Joint Air and Space Power Network Meeting

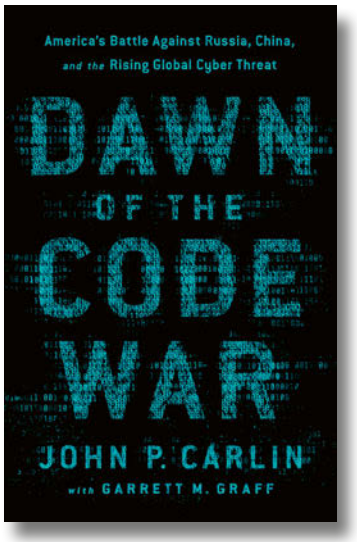
On 20 and 21 November 19 the JAPCC hosted the 6th Annual Joint Air and Space Power Networking Meeting in Kalkar, Germany. This meeting was the largest yet with 12 stakeholder agencies participating. Attendees included representatives from NATO HQ, HQ AIRCOM, NATO Science and Technology Organization, Competence Centre for Surface-Based Air and Missile Defence, Air Operations Centre of Excellence, Integrated Air and Missile Defence Centre of Excellence, European Defence Agency, European Space Agency (ESA), European Air Transport Command, Movement Coordination Centre Europe, and the European Air Group.

For two days the participants explained their programmes of work and conducted an extremely useful and productive engagement to address current issues facing nations and agencies in their efforts to advance Air and Space Power capabilities with the goal of deterring and defending against threats to our common security. One might think that with so many agencies focused on developing Air and Space Power capabilities there would be significant duplication of effort. However, and perhaps speaking to the success of the previous five JASPN Meetings, while there were numerous topics where interest is shared among multiple participants, there was little evidence of duplication of effort regarding any programmes. There was a widely shared desire to support each other's initiatives, to leverage each other's efforts and expertise to contribute to common goals and objectives, and to avoid developing capabilities in stovepipes. A summary matrix was created at the end of the event to depict which agencies have an interest in each of more than a dozen lines of effort. One of the key takeaways was an agreement for each agency to identify the key entry points to their planning cycle, so that others can more easily either contribute to or gain from complementary programmes; this being a main benefit of true collaboration.

A highlight of the meeting was a presentation on the European Space Agency by astronaut Brigadier General Thomas Reiter of the German Air Force. The Conference Hall was opened up to a larger audience of staff officers from JAPCC and nearby agencies including the NATO CAOC-Uedem, German Air Operations Command, and the German Space Operations Centre, who have particular interest in the ESA and its programmes. Needless to say the presentation was 'stellar', with the guest speaker captivating the JASPN members and the extended participants.

As the record of discussion and action items is circulated for confirmation, one thing that does not have to be confirmed is the utility of this venue to NATO and European Air and Space Power capability developers and programme managers to ensure they are aligned with the current security climate and better able to synchronize efforts for synergistic effect. The JAPCC considers it an honour to host this august forum and looks forward to the continuing collaboration among these prestigious agencies for the foreseeable future. ●

‘Dawn of the Code War’



By John P. Carlin with Garrett M. Graff, Public Affairs, October 2018

Reviewed by:

Lt Col Paul J. MacKenzie, CAN AF, JAPCC

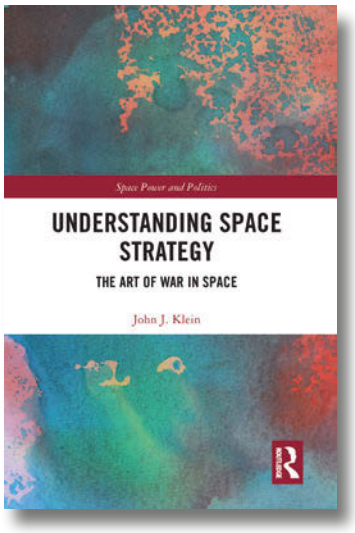
In Dawn of the Code War John P. Carlin shares many of his personal experiences tackling the exponentially increasing threats posed by actors in cyberspace against the US while serving as the Assistant Attorney General for National Security and with the Justice Department’s Computer Hacking and Intellectual Property Program. The stories of investigating and prosecuting criminal activity in cyberspace are a first-person account and told in parallel with anecdotes of the frustrating struggles and successes overcoming resistance to organizational change necessary in order to respond to them. Many of the major incidents and storylines contained herein which were reported in the media, and are familiar to cyberspace experts who have been tracking them, are expanded upon so readers will learn ‘the rest of the story’. Airmen will find some specific reading on the theft of aircraft designs not only interesting but most probably very concerning, particularly the theft of Boeing contracts and of documents/data on many aircraft (B-1, F-15, B-52, F-22 and F-35), and the extraordinary results when the USAF gathered ethical hackers for a ‘bug bounty’ to hack the USAF (the first bugs were found in under one minute). Concerned? Want to know more about the battle underway now in cyberspace, and how John Carlin and others faced and tackled the challenges? Whether you’re concerned about vulnerabilities or still need convincing about the severity of the threat, you must add this book to your reading list. ●

‘Understanding Space Strategy: The Art of War in Space’

Understanding Space Strategy: The Art of War in Space seeks to increase the level of understanding concerning the fundamental aspects of strategy for military operations in space, as well as an appreciation for the distinctive art of conducting war in space. This is no small feat, for while the basic nature of war is persistent, each domain possesses unique characteristics, and as yet our experiences related to conflict in space are still scarce.

Starting the discussion with space as a warfighting domain before moving-on to the frameworks of strategy and their applicability to space, the author, John J. Klein, provides a solid foundation for further discussion based on historic precedence. The book then looks at how nations with varying amounts of influence, both globally and in space, might build appropriate strategies to shape and guide their space activities. The author also discusses various commercial technologies that have recently gained traction, as well as highlighting some future trends, before concluding the book by examining concerns for the future.

This well-researched book is a great source for anyone interested in considering the enduring aspects of building a lasting presence in space. It will be of particular benefit to those who have had limited interaction with space operations, or perhaps more importantly those who are seeking to better understand their role as space operators within a larger context. ●



By John J. Klein, Routledge, Taylor & Francis Group, March 2019

Reviewed by:

Lt Col Henry Heren, USA AF, JAPCC

MQ-9B SkyGuardian

DEVELOPED FOR EUROPEAN AIRSPACE

- World's first STANAG 4671 certifiable MALE RPAS
- Matured system for collision avoidance (Detect and Avoid)
- More than 40 hours endurance for persistent reconnaissance
- Up to 2,177 kg payload across nine hardpoints for mission flexibility
- Open system architecture for rapid integration of new payloads
- Operational sovereignty and NATO interoperability

Multi-Mission | Single Solution

ga-asi.com

GENERAL ATOMICS AERONAUTICAL

Leading The Situational Awareness Revolution

ThalesRaytheonSystems

NATO'S PARTNER FOR COLLECTIVE DEFENCE

As NATO's trusted partner ThalesRaytheonSystems provides Europe's first-ever Integrated Air and Ballistic Missile Defence Command and Control System.

ThalesRaytheonSystems' unique international experience working in concert with an industrial network from NATO 17 Nations, make it the most reliable partner to lead NATO's evolving Air C2 efforts and to expand BMD programme to include all European territory.

ACCS team