Transforming Joint Air Power
The Journal of the JAPCC

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Edition 20, Spring/Summer 2015

As the Director of the Joint Air Power Competence Centre (JAPCC), it is my pleasure to introduce the 20th Edition of 'The Journal of the JAPCC'. In this special edition, we celebrate the JAPCC's 10th Anniversary by featuring articles reflecting on our past as the first NATO accredited Centre of Excellence and also looking forward to the future of Joint Air and Space Power.

Our Executive Director, Lieutenant General Joachim Wundrak, leads off this anniversary edition by revisiting the history and JAPCC's impact with decision-makers. The Assistant Director, Air Commodore Madelein Spit, continues with a look back on the invaluable leadership which enabled the JAPCC to overcome early obstacles and achieve its present level of success. She also includes perspectives from former Directors, Executive Directors and Assistant Directors on the centre's contributions to Joint Air & Space Power. Finally, the interview with Chief of the German Air Force, Lieutenant General Karl Müllner, discusses structural reforms in the German Armed Forces and the challenges faced by both the Luftwaffe and its NATO Allies in the post-ISAF environment.

The JAPCC also continues exploring our space education and training efforts with two articles discussing space situational awareness. The first, 'A Model of Space Debris Environment', illuminates the growing concern for space debris and presents a model to estimate impact on various satellite orbits. The second article, simply titled 'Space', articulates the modern military dependency on space capabilities and the unique advantages they bring to the fight.

The future of Remotely Piloted Aircraft Systems (RPAS) is another expanding field in which we are greatly interested. This 10th anniversary edition presents an article on RPAS integration into Non-Segregated Airspace. A second article, entitled 'Platform Autonomy', examines the various levels of autonomy and their future implications.

The role of enhanced training and exercises will be critical to the increased readiness, availability and interoperability of the Allied Forces. The article 'Exercise Virtual Magic' educates us on an initiative to improve E-3A and E-3D training with Mission Training through Distributive Simulation (MTDS). Additional articles also describe how innovative programs can affordably solve training problems. The 'Be advised, Training in Progress' article describes a new Specialized Heavy Air Refuelling Course (SHARC) designed to train Air to Air Refuelling planners. Finally, 'The Multinational Aviation Training Centre (MATC)' article explains how this NATO Smart Defence project is providing invaluable training in response to years of combat operations in Afghanistan.

Finally, the article 'Doing the Same with Less – Potential Synergies for NATO Air Power' takes a new look at fiscal constraints and how they impact Air and Space Power.

I congratulate the authors on their contributions to this 10th Anniversary Journal. I strongly encourage you to consider their efforts as we move forward and advocate for Joint Air Power.

The JAPCC team greatly appreciates your feedback and thoughts. Please visit our website at www.japcc.org, where you will find contact information and additional Air & Space Power content.

Frank Gorenc

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

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

Frank Gorenc, General, USA AF
Director

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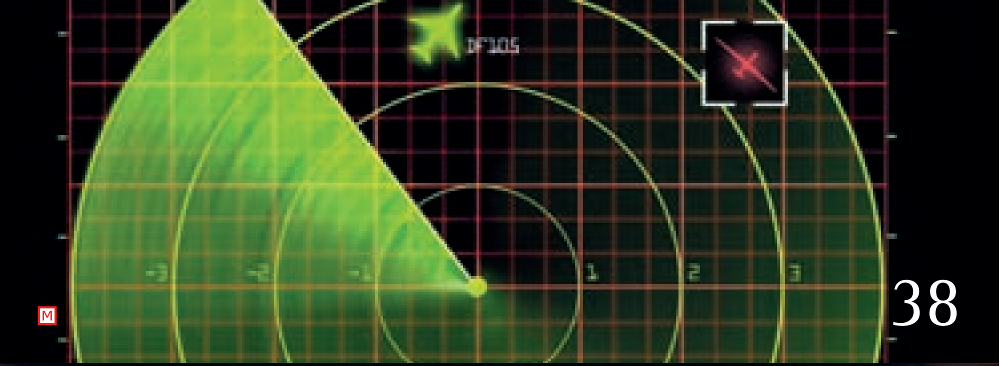

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Transforming Joint Air Power: The Journal of the JAPCC

Director Joint Air Power Competence Centre
Gen Frank Gorenc

Executive Director Joint Air Power Competence Centre
Lt Gen Joachim Wundrak

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Air Cdre Madelein M.C. Spit

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M **Denotes images digitally manipulated**

If We Are Not Talking About Air, Who Else Will?

10 Years of the JAPCC

The First Steps

With this journal issue, the Joint Air Power Competence Centre (JAPCC) celebrates its 10th anniversary. The JAPCC was and has been, since its accreditation in 2005, the first and largest NATO Centre of Excellence (CoE). Although the NATO Command Structure had, at that time, established Air Component Commands at Ramstein and Izmir, a centralized strategic-level Joint Air and Space Power body was lacking. In response to this need, the JAPCC was born. Its initial purpose was to foster the development of new ideas for the command, control, and employment of joint air assets and to facilitate appropriate measures for implementing these ideas by providing mission qualified subject matter expertise to the NATO Command Structure.

In 2002, the German Chief of Air Staff envisioned the establishment of the JAPCC, which would inherit personnel and materiel from the Reaction Force Air

Staff (RFAS), located in Kalkar, Germany. The JAPCC was declared an official NATO military body as of 1 January, 2005, following a Memorandum of Understanding (MoU) signing ceremony in 2004 at HQ SACT. Initially consisting of representatives from 16 Nations, the JAPCC added Romania as its 17th member in 2006.

The JAPCC was established to fulfil NATO's Air and Space Power-specific functional requirements with a General as Director and a Lieutenant General as Executive Director. They were supported by two Brigadier General Assistant Directors and a Colonel as the Director of Staff. The work force was configured as a matrix organization divided into six branches, each directed by a Colonel. A total of 76 Subject Matter Experts (SME), including 42 joint officer posts, was available to meet the operational requirements.

In order to promote the centre's efforts, the first edition of the bi-annual JAPCC journal was published in spring 2005, followed by the first annual conference in Kleve, themed 'How do we ensure that NATO Air Power remains relevant?' In addition to developing projects dealing with relevant Air Power topics, the JAPCC was also approached by NATO to be the chairman of several working groups, including the Air Operations Working Group (AOWG), as NATO's main body responsible for Air Power doctrinal publications and definitions.

Following these initial steps, the JAPCC broadened its approach and addressed other topics such as Force Protection, the Unmanned Aerial Systems (UAS) Flight Plan, and improving Space support to NATO operations. It was the first time that an organization had taken a holistic approach in the investigation of these air power-centric topics.

One of the milestones in 2007 was the dedication of the JAPCC's Conference Centre in Kalkar, which satisfied the demand for an internal and external discussion, conference and meeting focal point. As a result of the increased public attention brought by products such as the UAS Flight Plan and Air C2 C4ISR Roadmap, the JAPCC was also able to attract higher-ranking key note speakers and panellists from the military, academia, and industry to support their annual conference, emphasizing the relevance and importance of NATO Air and Space Power.

Going Operational

Due to the fact that Air Power expertise was underrepresented in many organizations, the JAPCC began to satisfy the demand, providing assistance to training events and NATO exercises. Involvement in ongoing missions also grew in importance. At the request of the Allied Command Transformation (ACT), the JAPCC reviewed structures within the Afghan National Army Air Corps (ANAAC) C2 Development program. The aim was to enhance operational capabilities and support progress. Visiting the theatre of operation and providing subject matter expertise offered a unique opportunity, further enhancing the JAPCC's visibility and providing insights to the SMEs involved.

'Although the JAPCC was focused on the transformation of NATO, it also had to consider transforming itself.'

On behalf of the Joint Force Command (JFC) Brunssum, the JAPCC also analysed the Air & Space Power contribution to the C-IED fight in Afghanistan. ISAF theatre visits, in-house research and wide-ranging consultation resulted in a number of recommendations to optimize the employment of Air & Space capabilities. Further support to current operations was provided by undertaking a comprehensive Force Protection estimate and reviewing the Kabul International Airport Ground Defence Zone plan. Both topics are, in some respects, ongoing activities and have formed the basis for lectures at the NATO School Oberammergau and other external entities.

The NATO Space Operations Assessment was published in January 2009, as requested by ACT. Topics addressed were Combined Space Operations, Space Situational Awareness and Access to Space, helping to develop space expertise through yet another first-time holistic approach.

Following a request from the Air Command, Izmir, the JAPCC deployed two SMEs on short notice to Poggio Renatico to assist with the 'Lessons Identified' process for OPERATION UNIFIED PROTECTOR (OUP). The deployment provided insight into the conduct of operations, adding extra value to ongoing projects. The visit resulted in a JAPCC report containing 47 recommendations concerning such topics as manpower, strategy, planning, organization, capabilities, and training.

Improving Ourselves

Although the JAPCC was focused on the transformation of NATO, it also had to consider transforming itself. Based on the fact that most of the previous RFAS personnel had been replaced by sponsoring nation SMEs, the JAPCC transformed its processes and its organizational structure. Most of the projects were managed using a NATO-Secret network environment, and therefore had limited public visibility. In order to spread the JAPCC message to a wider audience, it relocated primary production to a less restrictive network, aiming to make the JAPCC products available by publishing them on the internet. This shift also enabled the implementation of a world-wide collaborative environment, increasing research and remote access capabilities. The ability to publish classified products was retained. Decisions regarding the restriction of individual publications are still made today on a case-by-case basis.

'Especially in the arena of remotely piloted vehicles, the JAPCC entered uncharted territory and highlighted its leading role in independent thought and analysis.'

From an organizational point of view, the JAPCC process structure was also adjusted. As part of the internal JAPCC improvement campaign, the interrelationship between the annual programme of work, key stakeholders and product customers was highlighted. Focus areas like Space or Missile Defence were formulated and connected to products and stakeholders.

To further enhance the performance of the JAPCC, the branches were renamed and restructured. SMEs were assigned to new positions in order to cope with austerity measures that caused some nations to reduce or withdraw personnel. Despite these mitigation efforts, some key Air Power areas like Electronic Warfare/Suppression of Enemy Air Defence, and Intelligence, Surveillance and Reconnaissance (ISR) have been impacted by the reduction in JAPCC's capacity to provide support, for example to the NATO Joint ISR Panel.

2013 marked an additional structural reorganization in order to meet current realities and future requirements. Aimed at enhancing engagement capabilities and improved internal planning and control, the number of branches was reduced to four and the role of Director of Staff was redesignated as Chief of Staff (CoS). Additionally, the two Assistant Director posts were merged to a single post. An internal review of all SME job descriptions was completed, resulting in a demand for additional manning and a rebalancing of subject matter expertise, which was offered for bid to the sponsoring nations.

High Visibility

The same year, the JAPCC took over custodianship of the Allied Joint Publication 3.3 (AJP 3.3), NATO's core document with regard to Air & Space Power, which had not been reviewed and updated for some time. In cooperation with the Allied nations and other respective NATO bodies, the JAPCC developed a draft of the revised AJP 3.3 which is currently under ratification. The year 2013 also marked the start of a significant JAPCC study, 'Air and Space Power in NATO – Future Vector Project' (FVP), which focused on how Air Power can remain a key enabler for success and security. This was the first time that the JAPCC contracted external expertise to conduct a study. The JAPCC completed the FVP start paper in August 2013 and it served as the baseline for external consultant proceedings in 2014.

As a result of this consultancy, a three volume set of essays was published throughout 2014, consisting of 'Present Paradox – Future Challenge', 'Air & Space Power in NATO – Part 1' and 'Air & Space Power in

NATO – Part 2'. All volumes were distributed widely to key decision-makers within the Alliance in order to stimulate thought in advance of the JAPCC's annual conference, which then served as a platform for an intense discussion of NATO's 'way ahead' regarding Air & Space Power. It is now the JAPCC's task to take the outcomes of the 2014 conference and develop actionable recommendations for the future improvement of Air & Space Power in NATO.

Additionally, four other major publications were finalized in 2014: 'Improving Support to Future Air Advisor Operations', 'Enhancing NATO Joint Personnel Recovery Capability', 'Remotely Piloted Aircraft Systems in Contested Environments – A Vulnerability Analysis', and 'Air-to-Air Refuelling Consolodation – An Update'. Especially in the arena of remotely piloted vehicles, the JAPCC entered uncharted territory and highlighted its leading role in independent thought and analysis. The Air-to-Air Refuelling (AAR) paper contained several recommendations, one of which led to the development of an ACT-certified, NATO-specific AAR planners' course that is now being taught twice a year.

'The year 2013 also marked the start of a significant JAPCC study, "Air and Space Power in NATO – Future Vector Project" …'

The JAPCC was tasked to provide a report on the 'Military Implications of a Single European Sky' (SES) to the European Air Chiefs Conference (EURAC). It was foreseeable that SES would have a clear impact on the military use of the European airspace; therefore, a complete assessment that included recommended actions was required. JAPCC accomplished this task and briefed the Air Chiefs on 5 September, 2014, in Brunnen, Switzerland. As a result, the 'Position Statement of the EURAC on the JAPCC Report on the Implications of SES' was issued, stating the European Air Chiefs' common ground for proceeding with SES. Subsequently, the full report was finalized and distributed to the Air Chiefs in early January 2015.

Lastly, the JAPCC was invited to become the NATO Department Head for Space 2014, and, once ratified by the Military Committee, will assume the responsibility for NATO's Space training harmonization. This was a significant addition to the JAPCC's Education & Training portfolio. Where requested, the JAPCC Education & Training support activities also include the provision of Air & Space Power expertise to other NATO entities, such as the NATO School Oberammergau.

New Challenges

The year 2014 was characterized by a general rotation of senior leadership within our directorate and a continuing decline in the number of available SMEs. Sponsoring nations must be aware that without adequate and timely replacement of departing personnel, the JAPCC's ability to provide support will be hampered. In order to enhance the abilities of our SMEs, we established in 2014 a partnership with the University of Lincoln. This partnership offers every newcomer an opportunity to attend a research skills improvement course, obtaining an introduction to research methods and improving their academic essay writing techniques. Newcomers are also obliged to attend a two week Air C2 course within the German Air Operation Command. Sponsoring nations can be assured that they will get a better trained and educated Staff Officer back after their end of tour here at the JAPCC.

Summary

Recent years have demonstrated the JAPCC's ability to serve NATO and the nations as the single catalyst for Air and Space Power. Initially formed as an organization not yet optimized for its purpose, the JAPCC has transformed into a well-respected CoE for all aspects concerning Air and Space Power. Despite declines in manning and funds, we've managed to overcome all challenges through teamwork. Nevertheless, we still must question ourselves: how can we further improve in the coming years? Are we reaching the right level of customer? How do we proceed with our conferences and product creation? How do we enhance 'jointness' within our own organization?

The JAPCC team continues to strive for internal improvement while advocating for Joint Air and Space Power within the NATO Alliance, seeking to provide key decision-makers effective solutions to Joint Air Power challenges in order to safeguard Alliance interests.

Lieutenant General Joachim Wundrak

has since 2009 commanded the German Air Ops Command based in Kalkar. He is also the Commander of the NATO CAOC in Uedem and Executive Director of the NATO accredited JAPCC in Kalkar. Operational experiences include commanding a German Air Transport Wing, an assignment as European Air Group Deputy Director at High Wycombe UK, and two tours within the German EUFOR Contingent and Deputy Chief of Air Staff both with ISAF.

Looking Back …

JAPCC History Paved by Leadership

Since it was established in 2005, The Joint Air Power Competence Centre (JAPCC), NATO's first Centre of Excellence (CoE), was empowered to advance improvements and the transformation process of Joint Air and Space Power (A&SP) by delivering effective solutions through independent thought and analysis. Today with a history of successful products and growing partnerships with industry, academia and the military community, the JAPCC continues to build upon its hard-earned reputation as NATO's pre-eminent advocate for the development and enhancement of A&S Power.

This article is a compilation of reflections written by former JAPCC Directors, Executive Directors and Assistant Directors that captures the essence of the incredible vision, leadership persistence, and teamwork that led to the centre's many successful contributions to A&SP.

General (ret.) Robert H. Foglesong, USAF, Director, 2005

'It was a clear recognition of the impact of airpower on the security of NATO members when the JAPCC was formally approved. Airmen in every contributing nation recognized the JAPCC as an opportunity to optimize the use of the combined air assets of NATO and to capitalize on the innovative nature of those same airmen to shape the effective and efficient use of airpower in NATO. With a cadre of extraordinarily talented airmen, our biggest challenge was to bring the community together and take the next steps to excellence in air operations. A hardy "well done" to those dedicated airmen who worked diligently to stand up the JAPCC and lay the ground work for the successes to come.'

General (ret.) William T. Hobbins, USAF, Director, 2005–2007

'As a former JAPCC Senior leader and Director, our team's most significant contribution to A&SP was the research, coordination, publication and creation of the NATO Unmanned Aerial Systems (UAS) Flight Plan. This product was the result of careful research; a compilation of each Nation's UAS assets, capabilities and frequency plans that helped to ensure the community could communicate and survive within NATO's restricted airspace planning processes. By publishing this report, each Nations' UAS capabilities and flight requirements were presented in a manner that facilitated their development and integration within the Alliance. For our accomplishments, the JAPCC was awarded the Frost & Sullivan Award.'

General (ret.) Roger A. Brady, USAF, Director, 2008–2010

'My time as the JAPCC director, USAFE Commander and Commander of the Air Component Ramstein (2008–2010) was one of change. Despite being fully engaged in supporting combat operations in Southwest Asia, the need to address the future still remained. The JAPCC was obviously the best instrument for the task and proposed doctrine regarding what were relatively new mission areas for most Alliance members; space, cyber and remotely piloted vehicles. The centre did a superb job of presenting ideas to the nations of the Alliance, stimulating thought and discussion regarding the way ahead. From my perspective, the biggest challenge we had was not being physically co-located with the centre, and not having a single air component commander to focus the effort. Fortunately, after many years, we have moved to a single air component. This construct will serve to unify the message on air and space matters within the Alliance and add emphasis to the Centre's work. Today, the JAPCC remains critical to shaped thinking on all aspects of Air and Space Power application.'

General Breedlove, USAF,

Director, 2012–2013, Supreme Allied Commander Europe

'Our primary challenge was transforming into an organization that was more aware and responsive to meet the changing needs of NATO and the Alliance. Despite significant leadership turnover in more than 75 % of our key positions, we managed to deliver eight major projects and participate in more than 70 NATO committees, panels and working groups. Through intense teamwork, the JAPCC delivered on its key mission priority – to inform and enable decision-makers with joint air and space expertise.'

Lieutenant General (ret.) Hans-Joachim Schubert, GAF,

Executive Director, 2004–2007

'Within a period of 12 months, the residual personnel from the legacy Reaction Force Air Staff facilitated the flawless and speedy genesis of the Joint Air Power Competence Centre (JAPCC). The NATO Air Chiefs tasked the JAPCC to take a holistic approach to evaluating not only current air power theory, but also combat and combat support capabilities and methods. To this end a comprehensive vision, corresponding matrix organization and balanced multinational table of organization, supported by a sufficient budget and suitable infrastructure were required. In all respects, it was truly a remarkable accomplishment to satisfy the ambitious requirements of Supreme Allied Command, Transformation (SACT). Many thanks to my teammates who helped in the establishing of one of NATO's finest Centres of Excellence and my warmest compliments to all JAPCC staff members on a job well done over the last decade.'

Lieutenant General (ret.) Friedrich W. Ploeger, GAF

Executive Director, 2007–2010

'During this period, the JAPCC consolidated its position as the recognized champion of Air and Space Power. As NATO's first CoE, it successfully mastered re-certification; it effectively supported ongoing Alliance operations in Afghanistan, contributed to enhancing air-land integration, and continued to play a leading role in the development of concepts for UAS, C4ISR, and Joint Integrated Air and Missile Defence. One outstanding key product was the NATO Space assessment, which remains relevant to this day. In short: The JAPCC's ideas mattered – thanks to the most qualified work of its highly motivated team.'

Lieutenant General Dieter Naskrent, GAF
Executive Director, 2010–2012,
Vice Chief of Staff German Air Forces

'Congratulations to the JAPPC on its 10th Anniversary. As a former Executive Director, I'm very proud of having had the opportunity to contribute, together with all those highly motivated and well experienced men and women of the JAPCC, to the centre's mission. JAPCC personnel filled Chairmen, co-chairman, and penal position on numerous NATO steering bodies, provided custodianship to a number of key NATO doctrine documents, supported ongoing operations in Afghanistan, and worked on strategic issues concerning Air and Space domains. In order to build upon our hard-earned reputation and to remain relevant to NATO and the Nations, we started an improvement campaign to transform the JAPCC into an organization that is aware, responsive and capable of adapting to the ever-changing needs of NATO and its Sponsoring Nations. Thank you to the men and women of this unique Centre of Excellence for their outstanding work.'

Air Commodore (ret.) Ian Dugmore, RAF,
Assistant Director Transformation, 2006–2007

'A major project was to examine the role of the NATO Air Defence Committee. Much of the work fell on the shoulders of Colonel Renee Arns of the RNLAF, whose experience as an aviator and ability to approach issues with an open mind made him invaluable to the project's success. As a result, it was determined that the NATO Air Defence Committee continued to have a vital role, but its terms of reference should be expanded to make it an advocate of all aspects of air power, including the relatively new field of unmanned air systems.'

Air Commodore (ret.) Garfield Porter, RAF
Assistant Director Transformation, 2007–2010

'My time at the then emerging centre was focused on building a coherent body of work whilst striving to establish the JAPCC brand across NATO and beyond. The former included challenging the Alliance over its attitudes towards Space and Air & Space Future C2, especially as networking and our reliance on it increased. This work, in turn, provided a framework for promoting our environment in the round and, through the JAPCC Journal and Conference, taking the brand to an ever growing international audience.'

Air Commodore Paddy Teakle, RAF, Assistant Director Transformation, 2010–2011, Deputy Commander and Chief of Staff NATO Airborne Early Warning & Control Force Command

'While most CoEs concentrate their activity on discreet areas of military capability, uniquely, the JAPCC looks at an entire operational environment. This presents an enormous challenge. We cannot understand our own environment unless we understand how others view it. Therefore, during my time at JAPCC, I emphasized the need to educate others of the joint nature of Air and Space Power. I was also acutely aware that the vast majority of the centre's work looked out to distant horizons and I was determined to harness our intellectual capacity to tackle the operational problems of the day: problems that largely existed in the remote operational theatres of Afghanistan and Libya. There were notable successes in the areas of Force Protection and Counter-IED and this work has set firm foundations for future NATO operations. The key to these accomplishments was to focus our intellectual excellence under three themes; organizational reputation; procedural rigour and relevant output.'

Air Commodore (ret.) Jan van Hoof, RNLAF, Assistant Director Capabilities, 2008–2011

'Not only dreaming up great ideas but also bringing those ideas to the attention of the NATO Air Forces and other NATO bodies was a tremendous challenge. I truly believe that our collective efforts established our hard-earned reputation as NATO's pre-eminent advocate for the development and enhancement of Joint Air & Space Power. For example, the Space Operations Assessment for NATO garnered general support by highlighting the need to move forward in Space policy and doctrine development. Other successes include the Air-to-Air Refuelling Flight Plan, Personnel Recovery, NATO Counter-IED Operations and the Follow on UAV Flight Plan.'

Major General (ret.) Alessio Cecchetti, ITAF, Assistant Director Capabilities, 2011–2014

'From the time of my arrival at the JAPCC, I had the feeling of being in a unique military organization. A true Centre of Excellence, though not very well known to those outside the community, there was tremendous untapped potential hidden in within the organization. To solve this issue we started with an engagement program of visits to the contributing nations and other NATO Military Entities of interest in a campaign designed to show what the centre had to offer.

We also reviewed and streamlined the organization structure, optimizing the leadership structure to be based on a single Assistant Director, supported by a Chief of Staff and four specialized branches.'

Air Commodore (ret.) Antonie A. H. de Bok MA, RNLAF, Assistant Director Transformation, 2012–2014, Assistant Director, 22 March–22 August 2014

'When I arrived at the JAPCC, the organization was the subject of close scrutiny regarding its relevance. After a brief analysis, it became clear that the JAPCC desperately needed an overhaul to become more outward looking and agile in its response to the needs of its primary customers: NATO and the Sponsoring Nations (SN). We worked to bring vitality back into our efforts by focusing on teambuilding that improved effectiveness and drafting a Capstone Document to provide a clear and common understanding of purpose. The organization was streamlined by reducing 40% in overhead, 65% Admin/CIS support and reorganized from six into four Branches with new Terms of Reference. Moreover, a Planning & Control and Communication cycle was developed to guarantee timely output on topics of relevance for NATO and the SN, within budget constraints. In November 2013, the SN endorsed the renewed JAPCC, resulting in such recent lighthouse successes as "Air and Space Power in NATO – Future Vector"'.

From the current Assistant Director:

My sincere thanks to each former leader of the JAPCC who took the time to remind us of what happened during their tenure. Their efforts to support NATO's Joint Air Power truly built the foundation upon which we build today!

The JAPCC's SMEs are actively engaged across the spectrum of Joint Air and Space Power. To read more about the last six months in the JAPCC, please see page 71.

Air Commodore Madelein M.C. Spit

started her military career as an Air Force cadet at the Netherlands Royal Military Academy where she graduated in Aerospace Engineering in 1984. After her graduation, she had assignments in the field of Aircraft Maintenance and Engineering, weapon systems maintenance and engineering, and contributed to several acquisition projects. Her first command function was commanding officer of the Electronics and Avionics Division. Following, she was assigned to the Netherlands Ministry of Defence where she worked as policy adviser and staff officer. Thereafter she switched over to the area of Air and Missile Defence, where she held the position of Branch Head of Air Defence Systems, Weapons and Weapon Technology Branch. In the field of project and programme management, she was assigned to the post of the Netherlands Representative in the F-35 Program Office in Washington. After promotion to Air Commodore in 2007 she held the post of Director of Joint Air Systems in the MOD Armaments Directorate. She received her second command when she was appointed Commander of the Division for Infrastructure and Security. Since August 2014 Air Commodore Madelein Spit is the Assistant Director of the JAPCC.

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Luftwaffe Preparing for Future Challenges

Interview with the Chief of the German Air Force

Lieutenant General Karl Müllner is the Chief of the German Air Force (GAF). The JAPCC is grateful for the support we receive from the GAF and from Lieutenant General Müllner personally. Recently, he kindly agreed to answer some questions for this edition of the JAPCC Journal.

Sir, the German Armed Forces, the Bundeswehr, has started one of the biggest structural reforms of its history. The Luftwaffe has its share in this major reorientation of the Bundeswehr. From your perspective, what are the most important benefits but also major challenges?

Your assessment is quite right: The Luftwaffe is undergoing an intense and demanding restructuring programme affecting almost every aspect of armed forces, including procedures, structures, and financial austerity. The overall aim of the reform is to make the armed forces more deployable, efficient, and effective. To meet the given Level of Ambition, the structure of our Air Force has been scrutinized. We re-thought our way of doing business, to increase mission orientation throughout the Air Force. As a consequence, command structures have been flattened and focused, whilst decision cycles needed to be shortened and accelerated. Following an analysis of the work flow and the command, control, and communication processes, the new structure of the Luftwaffe has been reorganized. As a consequence, the total number of commands has been significantly reduced, thus streamlining command and control procedures. Functional areas cover now air operations, command of air and ground forces, and service support.

Overall, the Luftwaffe has taken important steps towards a new and efficient structure. Our personnel are demonstrating the high standard of training and skills no matter whether in Germany or on missions abroad. However, the reorientation is still far from completion.

Capability development is a permanent focus of the Luftwaffe, given the fact that there is still a lot to do. Future missions will challenge us in different ways, but most likely won't be less demanding than previous ones. Hence the Luftwaffe has not only to sustain a broad spectrum of capabilities, but must enhance and develop it in order to offer a broad range of options for our political masters. The emphasis is placed on existing capability gaps for the most likely operations striving for enhancements of the air force's combat capabilities.

The Luftwaffe has not only started a large scale restructuring programme but is facing a major shift concerning its fleet and equipment as well. How will the Luftwaffe change in the upcoming years?

First of all, the EUROFIGHTER has certainly become the showpiece of the Luftwaffe. More than 100 aircraft were delivered so far and have been put in service. We have one of the best combat aircraft of the world at our disposal. The EUROFIGHTER proved its tremendous capability as a fighter aircraft both in various air defence exercises and during air policing operations over Germany and NATO territory. Its capabilities were proven from September 2014 to January 2015 as Germany had sent four EUROFIGHTER to Ämari air base, Estonia, as our contribution to NATO's reassurance measures for our allies. However, the rapid introduction of multirole capabilities for our EUROFIGHTER is of utmost importance to me. The experience that our partners and allies made, for instance during Operation Unified Protector, have shown a substantial improvement in combat efficiency coming along with multirole capabilities. Therefore, it is our aim to bring a first module of multi role EUROFIGHTER aircraft in service as soon as possible.

Our TORNADO fleet remains the backbone of our air-to-ground capability for the time being. Due to the fact that this aircraft has still a vital task for tactical air reconnaissance and that it is the German contribution towards the nuclear sharing arrangements within NATO, I intend to keep the TORNADO within the Luftwaffe's portfolio for the foreseeable future.

Another topic of public awareness has been the future procurement of Remotely Piloted Aircraft Systems (RPAS) for our forces. Due to their inherent capabilities, RPAS have become indispensable means of modern air forces in joint operations. The service contracted RPAS HERON 1 in Afghanistan improved the situational awareness and security for our ground troops. We must ensure that the experience gained in the field of RPAS will be maintained and extended seamlessly after the ISAF mission that has just ended. This includes joint training and exercises as well as preparation for future operations. The Luftwaffe seeks to operate a more powerful and armed RPAS to meet the forces' requirements which should be readily available on the market, such as the Heron TP or the MQ-9 Reaper. This 'bridging solution' is to close the gap until a future Medium Altitude Long Endurance (MALE) RPAS, based on a possible joint European development that might be available more than a decade from now.

Air mobility is another one of the Luftwaffe's seven core capabilities. In December 2014 we have received our first A400M out of 40 aircraft. This represents a real giant stride for the Luftwaffe's air transport since we are receiving a transport capability that ranges from tactical to almost strategic dimensions. This aircraft is truly state-of-the-art. Starting with training for crews and for maintenance personnel, it is my declared aim to make the A400M operational as quickly as possible. Whilst an increasing number of A400M will be put into service, the robust and reliable C-160 TRANSALL – our workhorse – will leave the forces step by step towards the end of this decade. Thus, the Luftwaffe will not only enlarge its transport capacity but also enhance its air-to-air re-fuelling capability.

Air and Missile Defence has not only become top priority for the Alliance. It is also one of the main topics for the Luftwaffe. I am expecting that the good results of the Medium Extended Air Defence System (MEADS) development project might be utilized to complement and replace our aging but still capable PATRIOT weapon system. I am convinced that an open architecture framework allowing a step-by-step, modular and multinational approach is paramount to maintain our ground based air defence capability in the future.

The mentioned procurements and new equipment will contribute to the broad spectrum of capabilities the Luftwaffe can offer.

You have mentioned the 'broad spectrum of capabilities' the Luftwaffe must be ready to offer. In your opinion, what will be the role of Air Power in future conflicts?

2014 has painfully demonstrated that our picture of a Europe surrounded by friends must be called into question. Today, Europe is rather encircled by sources of insecurity ranging from the Ukraine conflict, the fight against the Islamic State (IS) in Iraq and Syria, the unresolved conflicts in the Middle East, instability in the Maghreb region – particularly Libya – to the Ebola epidemic in West Africa.

Looking into the future, one thing is certain as well: any new potential mission will differ from the previous one. What we know is that the future has never been a repetition of what happened before. In 2015, we will

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also have to respond to crises we cannot yet know today. In view of all these aspects, the importance of air forces is indisputable, their tasks ranging from classic collective defence with its primarily deterring function to tasks within the scope of international crisis prevention and crisis management.

Therefore, we must strike a new balance in which our contribution to collective defence capabilities has to play a more important role again.

Well-armed military forces, especially air forces with their reach, flexibility and precision, are paramount to guarantee peace and support to the international regime. The decisions taken by NATO nation's leaders at the Wales Summit in September 2014 are considering these inherent characteristics of air power when mentioning air power capabilities as a vital part of both NATO's assurance measures and the Very High Readiness Joint Task Force (VJTF), which will be established in the near future. Air Forces are a suitable and quick means to respond to an arising crisis.

In that respect, the substantial contributions of the Luftwaffe to the NATO Integrated Air and Missile Defence System (NATINAMDS), common capabilities like AWACS and the NATO Air Command Structure, the European pillar of NATO Nuclear Deterrence, the European Air Transportation fleet, as well as NATO's precise long range conventional air-to-ground capacities, offer critical capabilities for NATO's reassurance and deterrence posture.

We must also achieve an appropriate balance between mission-ready and mission-capable deployable forces whose level of mission-readiness allows Germany to make an adequate, credible contribution to the performance of Alliance tasks.

The mission in Afghanistan has just ended. NATO's Air and Space power capabilities played an important role right from the start. What changes will the Luftwaffe and its NATO allies face after the ISAF mission in Afghanistan?

The ISAF mission was and is not imaginable without proper use of air power.

As I mentioned before, air power will become more dominant in the near future because it enables rapid and tailored effects without deploying huge forces into theatre. Of course, an even more integrated approach to operations, calling for a closely interlinked and well-orchestrated joint campaign, will be required in the future. On the one hand, airpower must enhance its ability to conduct intelligence, surveillance and reconnaissance, as well as supporting joint forces mobility, based on a robust command and control network as well as multirole platforms to deploy modular and scalable weapons. On the other hand, sea and land forces must get the right level of training, equipment and understanding to cooperate with air forces, and vice versa, in order to fully exploit the air power operational advantage. The concept of Air-Surface Integration is therefore one of the focus areas where the Luftwaffe is currently making great efforts to improve our approach to joint campaigns.

We are still entering the post-ISAF era. The Alliance will surely experience a transition that has been labelled as a shift from 'NATO in operations' to 'NATO prepared for operations'. The challenge for all air forces NATO-wide will be to maintain a high overall level of operational readiness. We should be able to deploy into theatres of operations and start a combined and joint operation immediately. Interoperability of our forces is a key element for that. Hence, designing, conducting and evaluating common exercises and training in a smart, efficient and future-oriented way will be paramount to assure NATO air forces' preparedness for successful multinational operations.

To my understanding, the JAPCC will play a vital role in this respect. It has already proven extremely useful for the development of Air and Space Power. By combining these visions with current and future exercises, especially on the operational and tactical level, focussing on experiences gained from operations and exercises, JAPCC could evolve into an even more relevant think tank for the Alliance. It will be able to offer valuable recommendations on new ways of designing operations and on capabilities to be trained and exercised specifically. In this respect, the Future Vector Project will be a substantial part of NATO's outlook on the future role of Air and Space Power which is highly welcomed.

Lieutenant General Karl Müllner

is the Chief of German Air Force. He joined the Armed Forces as an NCO candidate in 1976 but changed his career path to become a line officer. In 1982 he graduated as an aircraft commander, F-4F Phantom. From 1983 to 1992 he served as Fighter aircraft commander, flight and weapons instructor as well as flight operations and armament officer and squadron commander at the Fighter Wing 74 'Mölders' (Neuburg). After graduation of the General staff officer training at the Bundeswehr Command and Staff College in Hamburg, he served in various staff positions before he became Commander Flying Group, Fighter Wing 73 'Steinhoff' (Laage) in 1993 and Commander of Fighter Wing 74 'Mölders' (Neuburg). He gained experience in International Military Policy related matters at the MOD both in Bonn and Berlin. In 2007 he was assigned as Commander, 2nd Air Division (Birkenfeld). In 2009 he was appointed as the ACOS, Politico-Military Affairs and Arms Control in the Armed Forces Staff at the MOD in Berlin. Since 2012 he has taken his current position as the Chief of the German Air Force at the German Air Force Headquarters (Berlin-Gatow).

Space

How Hollywood's Movie 'Gravity' Highlights NATO's Need for Space Situational Awareness

Lieutenant Colonel Steffen Neumann, DEU AF, JAPCC

Introduction

In 2013, the Hollywood movie 'Gravity' brilliantly depicted the effects that Space debris can have on objects orbiting the earth. The story is more fact-based than fiction. The Space Shuttle crew conducts an Extra-Vehicular Activity (EVA), working on a captured satellite. While the mission specialist and the mission commander repair a broken satellite panel, they are ordered to immediately abort the mission, execute the emergency satellite release procedure and return to the Space Shuttle. Two minutes later, the Space Shuttle is destroyed and the crew, except the mission commander and mission specialist, are killed. What happened? An Anti-Satellite (ASAT) weapon test created debris which hit other satellites and initiated a cascade of destruction, known as the Kessler Syndrome. The resulting cloud of debris took out the shuttle and killed the crew.

Is the story behind this movie science fiction or does it have a more serious background? Today, the amount of Space debris produced by mankind since the first rocket launch in 1957 has reached an alarming level. Such a destructive event in Space is only a matter of time.

Real-World Cases

In 2007, a Chinese ASAT test created more than 150,000 pieces of debris larger than 1 cm. Approximately 3,300 of these debris pieces are trackable with today's sensors.[1] The resulting debris cloud ranges from altitudes of 200 km up to almost 4,000 km, while the bulk of debris ranges from 800 km and 900 km.[2] Today, more than 3,000 pieces of trackable debris are still on orbit and will remain there for decades. This ASAT test produced more than 18 % of today's total debris population in orbit.

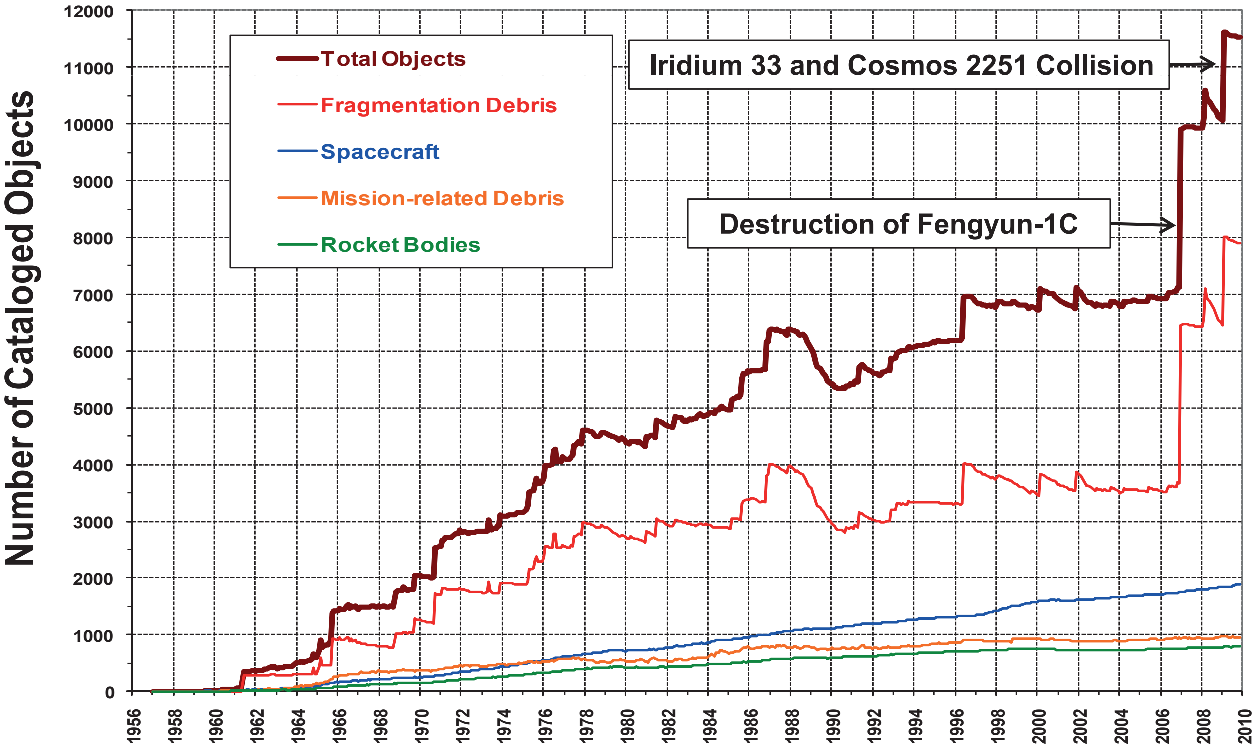
The 2009 collision of the Iridium 33 satellite with the Russian Cosmos 2251 satellite is the only other publically known event to date that significantly increased the Space debris population. The two satellites collided with a relative speed of 11.57 km/s, creating another 2,500 trackable debris pieces in Low Earth Orbit (LEO) between 650 km and 900 km.[3]

In addition to these two sources of debris, there are other sources like dead satellites or payloads, upper rocket stages, mission related objects (MROs), solid rocket motor slag residues, paint flakes, multilayer isolation foils, fragments after the brake-up of satellites, and so on.

The figure below shows the Space Surveillance Network's (SSN) tracking of Space debris larger than 10 cm. This data is continuously updated by the US Joint Space Operations Center (JSpOC).

Today the US JSpOC makes between 380,000 and 420,000 observations every day, tracks more than 22,000 objects (including 1,100 active satellites) and provides more than 500,000 Conjunction Summary Messages (CSM)[4] to worldwide users every year.

Although there are natural effects (decay and re-entry) that lessen the amount of orbital debris, mankind is creating more debris rapidly than it is reduced by the Earth's atmosphere. As a consequence, the risk of a collision on orbit is rising. In the worst case, this could produce a debris density on an orbit that would deny its future use for a very long time and increase the probability of mission failure while flying through that orbital band to reach higher altitude orbits.

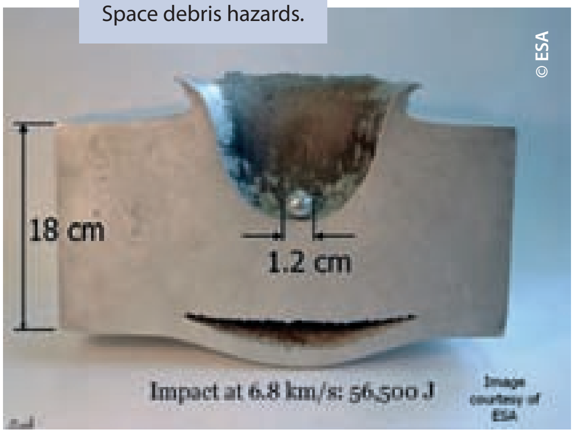


NASA Orbital Debris Program Office: Orbital Debris Quarterly News, Volume 14, Issue 2, April 2010.

Space Situational Awareness

Space is a congested, contested and competitive domain. Modern military forces are dependent on Space capabilities and the advantages they can bring to the fight. According to US doctrine, 'Space Situational Awareness (SSA) is fundamental to conducting space operations. It is the requisite current and predictive knowledge of the space environment and the Operational Environment upon which space operations depend'.[5] The effects that resulted from the aforementioned Chinese ASAT test significantly raised the attention of scientists, politicians and military senior leaders as to the importance of SSA. But what is SSA?

Space debris hazards.

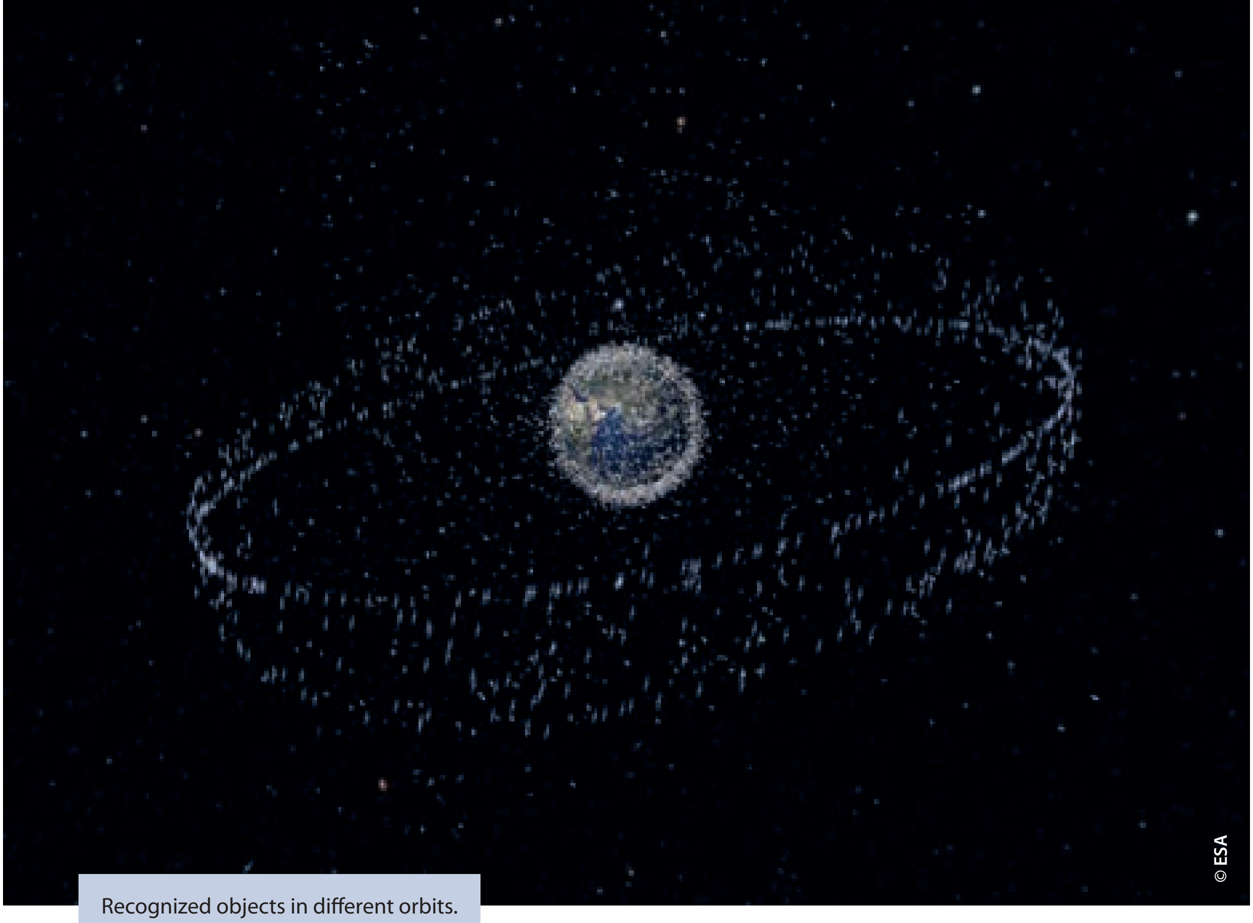


There is no commonly agreed definition. The interpretation of SSA varies from academic, commercial, civilian and military users.[6] For the purpose of this article, we will use the following definition:

'SSA is the knowledge of Space-related conditions, constraints, capabilities, activities and the operational environment upon which Space operations depend.'

This definition focuses on the military perspective and includes elements which can influence the Space System and the related activities in and outside the battlespace.[7] The main purpose of SSA is to allow friendly forces to employ Space capabilities and exploit them to the maximum extent. SSA also provides information on adversary Space capabilities, enabling friendly forces to take appropriate countermeasures, i.e. deceiving, degrading, delaying or denying adversary use of Space.

A prerequisite to gain SSA is the ability to detect, track, identify and maintain custody of objects and events in Space. Based on the US Satellite Sensor Network



Recognized objects in different orbits.

sensor's inputs, the JSpOC provides specific SSA information accessible via its 'Space Object Catalogue'.[8] This data is available to all levels of command (tactical to strategic) and supports observation, planning, execution and assessment.

The Need to Include Space in NATO's Common Operating Picture (NCOP)

NATO no longer owns or operates satellites.[9] Nevertheless, NATO is heavily dependent on Space capabilities, e.g. SATCOM, Imagery Surveillance and Reconnaissance (ISR), integrated tactical warning and attack assessment, weather information and Position, Navigation and Timing (PNT, i.e. Global Positioning Satellite (GPS)).[10]

The development, employment and operation of Space capabilities is an expensive business and is usually a nationally sensitive topic. Most Space-based capabilities are high demand, low density and require efficient and effective de-confliction.

As stated in the US Doctrine JP 3-14, SSA is a prerequisite to successfully conduct Space operations. Within the Alliance, a few nations argue that NATO is actually not conducting Space operations due to the fact that NATO does not own or operate satellites. This interpretation is short sighted, as command and control of satellites is only one element of Space operations. The core of NATO Space operations is the effective and efficient coordination of Space capabilities, products and services offered to NATO (nationally or commercially) to conduct operations.[11] These capabilities and their operating environment must be incorporated into the NCOP.

NATO and SSA

Does NATO need to be fully aware of the entire Space Domain? – Definitely not! The basis for NATO's Space Operations is outlined in AJP 3.3 (A). But it has to be understood that the Space Operation mission areas are interdependent and intrinsically linked. It is essential for NATO to have proper information continually derived from SSA to ensure Space Force Enhancement. Nevertheless, in the context of holistic thinking and to provide comprehensive recommendations to leadership, additional data and information regarding all Space operation mission areas are required.

Based on NATO's dependency on Space and the associated threats, NATO has to start to actively define the required data and information that nations and commercial companies must provide to ensure an effective and efficient coordination of Space Force Enhancement capabilities. NATO also requires educated and trained personnel who ask the right questions in order to interpret and assess the possible impacts on operations and advise commanders.

SSA Support to NATO Operations Examples

Space Weather Effects. Solar activities can influence the Earth's ionosphere and constrict the propagation of electromagnetic waves. As a consequence, SATCOM or GPS can be degraded, denied, disrupted, or even destroyed. Space weather prediction, as part of SSA, is able to provide timely regional forecasts and effects to the use of radio communication and GPS. This information enables planners and war fighters to create and apply contingency plans.

ISR and OPSEC. ISR satellites are able to provide images of different spectral wave lengths. Knowledge on the orbital parameters and the capabilities of the sensors will help the ISR community to adjust observation windows, and help to support targeting and Battle Damage Assessment (BDA). Knowledge of a potential adversaries' Space based ISR capabilities will help NATO to optimize Operational Security (OPSEC).

BMD Engagement and Collision Avoidance. Space debris might become a problem for Ballistic Missile Defence (BMD).

- Exo-atmospheric BMD: if an interceptor has to cross a region of high debris density, the potential for the interceptor to be hit by debris increases. Furthermore, Space debris can complicate the interceptor targeting process. Both scenarios can lower the probability of kill and thus lower mission success rate.
- Endo-atmospheric BMD: depending on the re-entry orbit of the debris, BMD systems could interpret such debris as a ballistic missile. This could lead to unnecessary engagements.

For those scenarios, SSA can support BMD to identify the right target or provide optimized windows of engagement.

Conclusion

The Hollywood movie 'Gravity' impressively depicts how Space debris can degrade the use of Space. Today, the question is not *IF* debris will hit a spacecraft or other debris; the question is *WHEN* and *WHERE*, and *WHAT* the consequences will be to NATO's warfighting capacity. Space is already congested, contested and competitive. This condition will become more acute as the use of Space grows.

Due to NATO's Space dependency and the contribution Space brings to operations, NATO has to have situational awareness on Space, similar to the domains of Air, Land, Maritime and Cyber. Although SSA and data sharing are a very sensitive topics to the Space faring nations, NATO must define its level of required situational awareness in the Space domain, set requirements and establish exchange mechanisms to fulfil those requirements.

Recommendations

Due to NATO's Space dependencies and the threats that are associated with the deprivation of use of Space capabilities, NATO would be well advised to:

4. Build a structure within NATO that is able to provide Space support to operations.
5. Educate and train a cadre of Space Operations personnel.
6. Develop an overarching Space vision, strategy and policy. ●

1. Define an understanding of SSA and its relevance to NATO operations.
2. Define information requirements to build up SSA.
3. Negotiate appropriate SSA data exchange mechanisms with nations and other providers.

AJP-3.3 (A): Space Operations Mission Areas

Space Control	e.g. SSA, offensive/defensive Space control
Space Force Enhancement	PNT, SATCOM, ISR, Weather, ITWA
Space Support	e.g. Space lift, satellite operations
Space Force Application	Attacks from and through Space

1. NASA, 'Orbital Debris – Quarterly News', Volume 12, Issues 1, Jan. 2008, available from: http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv12i1.pdf.
2. Kelso, T.S., Analysis of the 2007 Chinese ASAT Test- and the Impact of its Debris on the Space Environment, Technical Paper, AMOS Conference, Maui, Hawaii, 2007, available from: http://celestrak.com/publications/AMOS/2007/AMOS-2007.pdf.
3. A.Tan, T.X. Zhang and M. Dokhanian, Analysis of the Iridium 33 and Cosmos 2252 Collision using Velocity Perturbations of the Fragments, Advances in Aerospace Science and Applications, Volume 3, Number 1 (2013), pp. 3–25, Department of Physics, Alabama A&M University, available from: http://www.ripublication.com/aasa/aasav3n1_02.pdf.
4. The CSM is a fixed-format ASCII formatted message which contains information about a conjunction between a high-interest space object (hereafter referred to as 'asset' or 'primary satellite') and another resident space object, which will be referred to as the 'conjuncting satellite'., www.space-track.org, CSM Guide, available from: https://www.space-track.org/documents/CSM_Guide.pdf.
5. US Joint Staff, JP 3-14, p. II-1.
6. As exapmles:
   ESA: 'SSA aims, ultimately, to enable Europe to autonomously detect, predict and assess the risk to life and property due to man-made Space debris objects, reentries, in-orbit explosions and release events, in-orbit collisions, disruption of missions and satellite-based service capabilities, potential impacts of Near-Earth Objects (NEOs), and the effects of Space weather phenomena on Space- and ground-based infrastructure.' Source: http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/About_SSA.
   US JP3-14 Doctrine: '. . . is the requisite current and predictive knowledge of the Space environment and the OE upon which Space operations depend. SSA involves characterizing, as completely as necessary, the Space capabilities operating within the terrestrial environment and the Space domain.', Joint Publication 3-14, Space Operations, US Joint Staff, 29 May 2013.
   NATO, proposed by NATO STO: 'NATO Space Situational Awareness is the knowledge and the understanding of military and non-military events, activities, circumstances and conditions within and associated with the Space environment or Space related systems that are relevant for current and future NATO interest, operations and exercises.' NATO STO, SCI 229, available from: https://www.cso.nato.int/ACTIVITY_META.asp?ACT=2069.
7. The Space System is composed of the Space segment, terrestrial segment and the link. The Space segment contains all orbital elements, while the terrestrial segment is composed of the satellite and payload control as well as the end user element.
8. The US SSN is the most advanced sensor network in the world. It includes dedicated Space surveillance sensors, as well as contributing sensors (e.g. Missile Defence Radars). In addition to the US SSN, there are some Russian SSA sensors, as well as the French GRAVES and the German TIRA Radar. Until today, no other nation is able to achieve both quality and quantity of SSA data provided by the US.
9. The last NATO owned satellite, NATO IV, stopped operational service in 2010. http://www.nato.int/cps/en/natolive/topics_50092.htm.
10. These services are functions of the mission area of Space Force Enhancement as laid out in NATO AJP-3.3(A) – Allied Joint Doctrine for Air and Space Operations. Other mission areas are: a. Space Support – Space Lift, Reconstitution of Space Forces, Satellite Operations; b. Space Control – SSA, Offensive Operations, Defensive Operations; c. Space Force Application.
11. NATO Space 'Operations Iceberg' – Looming Danger of a Non-holistic Approach, JAPCC Flyer Edition 10, available from: http://www.japcc.org/publications/flyer/Pages/default.aspx.

Lieutenant Colonel Steffen Neumann

serves as a Staff Officer in the Operations Branch of the German Space Situational Awareness Centre. He joined the German Air Force in 1996 and holds two Master Degrees in Aerospace Engineering and Business Administration/Project Management. His officer career includes tours of duty as Tactical Control Officer HAWK, Reconnaissance Officer PATRIOT and Conventional Arms Control Officer. He has more than 10 years' experience in GBAD Command & Control and Operational Planning, including tours as company commander of a GBAD Maintenance/Supply Squadron and a PATRIOT Squadron. From 2012 to 2014, Lieutenant Colonel Neumann served as a Space SME at the Joint Air Power Competence Centre. He participated in the NATO ISAF mission as an Army Task Force Air Liaison Officer in 2010/11.

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Exercise Virtual Magic

Making the Leap into the Virtual Training Environment

By Lieutenant Colonel Alex S. MacLean, USA AF

Introduction

In April of 2014 the E-3A and E-3D Airborne Warning and Control System (AWACS) Components conducted Exercise VIRTUAL MAGIC, in which AWACS Combat-Ready mission crews at Geilenkirchen Air Base, Germany, linked operations with Combat-Ready mission crews at RAF Waddington, UK, in order to conduct a simulated exercise in the virtual environment. Virtual Magic was the culmination of an extensive effort by the two Components to launch an operational exercise within the Mission Training through Distributive Simulation (MTDS) and Distributive Mission Training (DMT) environments.

Limits of Conventional Flight Simulation

In general, simulators provide a tool for pilot training that allows saving fuel and maintenance costs as well as mitigating the risk associated with diverse flight manoeuvres in a live training mode. Simulators originally only provided training features for basic flight control of a single aircraft. Conventional simulator training, in general, offers structured environments with scripted procedures that do not support combined and joint combat training. It limits training to procedures and processes inside the weapon system, not supporting complex, multi-platform combat environments. As an example, conventional fighter simulators are able to

simulate flight operations, but external inputs from an AWACS or Control and Reporting Centre (CRC) are prescripted and usually injected by a non-Command and Control entity. This limitation, within most current simulators, leads to unrealistic and ineffective simulated events. Vice versa, the CRC and AWACS crews need to be provided scripted inputs from fighters and other external weapons systems.

Advanced Simulation – MTDS

Advanced simulator technology is capable of simulating complex flight scenarios in virtual tactical environments that involve multiple aircraft and the mutual exchange of command and control data. MTDS and DMT are current, state-of-the-art simulation concepts, developed for and used by the US Air Force (USAF) on a daily basis, which additionally allow for web-based combined simulator training at geographically separated units. The general concept for MTDS is to connect separate flight simulators in a virtual environment with minimal structural constraints, so that the simulated events can evolve and change dynamically, thus emulating a real-world operation or exercise. By introducing different weapons-system simulators in a combined, virtual environment, aircrews are offered the opportunity to conduct training in direct collaboration with other alliance aircrews. Furthermore, MTDS provides a 'man-in-the-loop concept' which significantly reduces the realism gap that currently exists between live operations and the simulator training historically provided. Therefore MTDS/DMT does not only lead to considerable reduction of live-fly training requirements with the associated costs. It also represents a significant improvement of aircrew training quality, offering an unprecedented variety of training options in combined and joint flight operations.

Therefore DMT does not only reduce costs and enhance the quality of training, but it leads to extraordinary cost savings and can offer tailored training objectives.

Introducing MTDS in NATO

The US Air Force has developed a robust DMT network to facilitate exercises such as VIRTUAL FLAG and ARCTIC TRIAD. The 552nd Air Control Wing (ACW), Tinker Air Force Base, Oklahoma (home to six AWACS and two Air Control Squadron (CRCs) line squadrons) has been executing DMT for the past seven years. The DMT training includes connectivity with fighter simulators, bomber simulators and Command and Control platforms throughout the Combat Air Force (CAF). This training is used for Basic-Qualification Training, Combat-Ready Training and spin-up training for specific operations.

Within NATO, the MTDS project has been a major initiative for the past seven years. Various NATO-sponsored work groups and armament councils, such as the Model and Simulation Group 128 and Joint Capabilities Group Command and Control, have studied the feasibility of conducting DMT throughout NATO. The primary driving forces for the development of MTDS and DMT are the resource-constrained environment faced by NATO nations and the increasingly limited airspace in which to conduct air operations.

MTDS Adaption for NAEW&C

Headquarters NATO Airborne Early Warning and Control (NAEW & C) Force Command is committed to develop its own MTDS network in order to advance current simulator capabilities.

Throughout the development of DMT at HQ NAEW & C Force Command, the E-3A Component has executed various test and development exercises. Exercise GOAL POST was the most successful and significant of these experiments where the primary mission simulator at Geilenkirchen Airbase's Mission Training Centre (MTC) connected to laboratories at NATO Communication and Information Agency (NCIA) in order to prove the feasibility of connecting to outside-entities through established networks. The success of Exercise GOAL POST paved the way for the execution of Exercise VIRTUAL MAGIC.

Exercise VIRTUAL MAGIC

The planning and preparation of VIRTUAL MAGIC was extremely challenging. Hundreds of technical, security and political requirements had to be fulfilled in order to connect the MTC at Geilenkirchen with the Air Battlespace Training Centre (ABTC) at Waddington. The technical requirements were relatively simple to solve due to the fact that the two MTCs were constructed and managed by the same contracting company. The political hurdles involved receiving special permission for information exchange between NATO's governing bodies, United States State Department and the British Ministry of Defence. Finally, the security requirements had to be established to ensure the integrity and security of information that was within the NATO Secret domain. Despite the challenges, the teams from Waddington, Geilenkirchen and SHAPE persevered and accomplished all established requisites.

© NATO E-3A Component

The exercise itself was a Major Joint Operation scenario that integrated lessons learned and challenges experienced in Operations ALLIED FORCE, AFGHAN ASSIST and UNIFIED PROTECTOR. Within the scenario there were over 100 aircraft and command agencies being simulated. It took place over a large territory that required two AWACSs for airborne command and control. The primary objective was to force extensive coordination and collaboration between the two AWACS crews on-station, which were the primary training audience. These AWACS crews divided the battle management area into two areas of responsibility, establishing a division of labour for defensive and offensive operations control and air-to-air refuelling as well as coordination with external command and control agencies. The roles of the fighter pilots, Combined Air Operations Centre (CAOC) and CRCs were simulated by the Exercise Control (EXCON) element consisting of a large cadre of contactors and Air Battle Management instructors located in both Geilenkirchen and Waddington, connected through the network. The EXCON worked off basic guidelines, but reacted dynamically and 'real-time' to the inputs of the AWACS crews, which created an extremely flexible and realistic scenario.

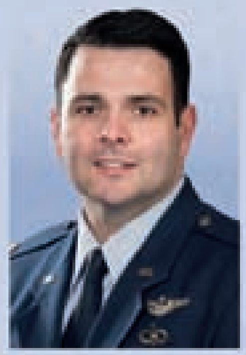
Conclusion and Outlook

At all levels of training, to include basic instructional and advanced knowledge training, the MTDS concept offers a training environment that in some instances can even surpass live training. Within the distributive environment, simulations can present realistic scenarios that are just not feasible in the real-world environment due to resource constraints. Thus, the major advantages of DMT are significant cost savings and unprecedented training value with regard to complex, dynamic, tactical air operations.

Exercise VIRTUAL MAGIC marks the most significant step in the development of MTDS within NATO and serves as the bench-mark event for further funding and execution by the different NATO nations. The NAEW & C Force is dedicated to further expanding the MTDS initiative and is actively seeking more training partners to participate in the VIRTUAL MAGIC training initiative. As stated by Major General Both, German Air Force, NAEW & C Force Commander: 'The NAEW & C Force, with its GBR E-3D and NATO E-3A components, has already paved the way within the MTDS initiative by connecting its MTC at NATO Airbase Geilenkirchen with the ABTC at RAF station Waddington. Exercise VIRTUAL MAGIC was a great success and applauded by the aircrews. The NAEW & C Force will invest in becoming a partner within the US DMT System, not only ensuring highest quality training for its aircrews, but also demonstrating, once again, that this unique Force is at the leading edge of NATO nations' training philosophy and infrastructure.'

Lieutenant Colonel Alex S. MacLean

is the Chief of E-3A Aircrew Training Branch, Headquarters NATO Airborne Early Warning and Control, SHAPE, Belgium. He leads and manages multiple training programs, to include synthetic training devices, for the NATO aircrews assigned to operate Alliance's 17 E-3A/AWACS aircraft. As the branch chief, he is responsible for identifying critical E-3A training shortfalls and pursuing material and non-material solutions to ensure future relevancy for future operations. Additionally, he coordinates E-3A participation in experimental training exercises in which test initiatives are organized with acquisition and industrial partners. Lieutenant Colonel MacLean was commissioned in 1999 through the Officer Training School at Maxwell AFB, Alabama. A Senior Air Battle Manager with more than 2,000 hours in the E-3A and E-3B/C, Lieutenant Colonel MacLean has flown in and supported numerous contingency operations including Operations SOUTHERN WATCH, NOBLE EAGLE, ENDURING FREEDOM, and IRAQI FREEDOM.



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Be Advised, Training in Progress

Operational-Level Air-to-Air Refuelling Planning Course Begins to Meet a NATO Need

By Major Joshua 'Beaker' Chambers, USA AF, JAPCC

Introduction

Not every useful skill is readiliy visible. That is why the 15 Specialized Heavy Air Refuelling Course (SHARC) Course-0 and the 12 Course-1 graduates do not appear different, but they are! After two busy weeks and nearly 80 study hours, these students are the first NATO-trained Air-to-Air Refuelling (AAR) planners, ready to support the next Joint Air Force Component (JFAC) exercise or real-world event.

Lack of AAR Planning Training in NATO

Until now, NATO JFACs have relied upon USAF-trained AAR planners to meet the needs of this unique and complex challenge. The need for this training was made readily apparent during OPERATION UNIFIED PROTECTOR (OUP) in April 2011. At the start of the operation, the supporting JFACs were in desperate need of trained planners and the only ones available were from US Air Operations Centres (AOCs). Without their expertise, the daily Air Tasking Order (ATO) would have been excessively delayed and the Commander, JFAC's objectives put at risk. Throughout the operation NATO planners' experience grew; however, the AAR planning puzzle remained a daily reminder of NATO's need for this training.

After the dust settled and the lessons were written down, the JAPCC conducted a critical look at AAR capability in NATO. In the 2014 'AAR Consolidation – An Update', one of the recommendations is the introduction of a common training programme for AAR planning staff as a pre-employment requirement to assignment in a NATO Air Operations Centre. This objective looks at two issues, the first associated with OUP and second with the new NATO Command structure. When declaring JFAC Initial and Full Operating Capability, the training gap issue was not adequately addressed even though it was one of the

OUP Lessons Identified. What is not fully understood, perhaps, is why AAR planning is different from other JFAC planning positions.

The AAR Puzzle

For those unfamiliar with AAR planning, it must overcome many compatibility restrictions, national limitations of receiver and tanker nations, and is made more complex because it is the last element of the daily plan to be coordinated. The technical compatibility restrictions limit which tanker can refuel a given receiver, or mandate a limited altitude or speed range. National limitations in place for multinational operations apply to AAR, as one example, a nation may not agree to provide support to kinetic operations, thereby restricting their tanker's available receivers. Finally, the part most resembling a jigsaw puzzle is the time where AAR is added into the daily plan. As the last piece of daily plan, all receiver request times are in place and assigned to a geographic area. The AAR planner must fit their limited resources such that they meet the requirements of multiple receivers from different nations, applying the aforementioned restrictions in addition to doling the always limited fuel to meet the AAR need. A common problem during planning is a tanker has excess fuel after meeting some requirements, but there are no receivers within hundreds of miles to make use of it.

This type of complex puzzle solving is not taught to tanker aircrew because it is not required for the execution of their mission as single aircraft or in formation. It is unique to operational level planning and, for the past 15 years, has been taught successfully in the US with a specific mix of lectures, practical exercises, and evaluations.

Starting Point

The SHARC begins with the assumption the student knows what AAR is but may not be familiar with all the details. It also assumes the student has an idea of how a JFAC works but not necessarily where AAR fits in the cycle. The course builds on these foundations of knowledge rather quickly in the first two days, inundating the student with timelines, definitions, NATO tanker and receiver capabilities, receiver missions, JFAC

priorities, and interoperability concerns. Then, a sharp focus on the tankers themselves illuminates the concerns and constraints when basing heavy aircraft in an area of responsibility away from their home bases. Add a smattering of airspace design and operational case studies and the student is ready to attack the 'Beautiful Mind Board'.

The 'Beautiful Mind Board' is a reference to the 2001 film about American Nobel Laureate John Nash and scenes where he would write theories only he seemed to understand on a blackboard or his dormitory windows. The result of an ATO days' worth of receiver requests and the solutions the planners devise creates a similarly confusing mass of information decipherable only by the initiated.

From Theory to Practical Challenges

The largest challenge faced by the students is putting the knowledge from the first week into practice. The students are provided the same amount of time they would be allotted during a 24 hour ATO cycle to take the completed AAR requests and produce an executable schedule. The first iteration requires about 90 separate AAR requests be completed, with nearly 40 tankers at their disposal. Without any restrictions other than mechanical fitting, this allows the students to experience the process from start to finish. Most use slightly over half of the available tankers. Their second iteration increases the number of requests by 50 % while adding some restrictions preventing some receivers from refuelling from certain tankers. This brings the realism closer to real operations and stresses their use of the multi-capable assets. The third iteration increases the number of requests again, though only by 20 %, which brings the number to the approximate level of recent Alliance operations. The true challenge comes with the caveats and restrictions placed on multi-national AAR pairings. These are

'The dynamic nature of today's operations require a skilled tactician to understand all of the requirements placed on making the initial schedule, then to make changes to missions and anticipate the subsequent impacts.'

dramatically increased, to a realistic level. Finally, the tanker resources available are also reduced closer to the level they might see in a future operation. This last iteration also brings the negotiation between AAR planners and receiver planners into play, as not every request can be met as initially made and must be negotiated to ensure mission accomplishment or, in some cases, subject to prioritization. Each of these days creates an executable plan, which leads to the final skill these students will need.

AAR Dynamics

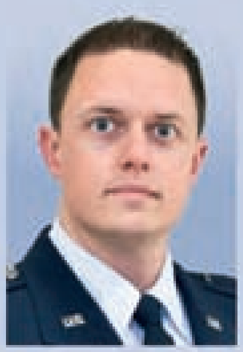
Executing a day's AAR plan will, unfortunately, never be as simple as letting the schedule run without some active supervision. The dynamic nature of today's operations require a skilled tactician to understand all of the requirements placed on making the initial schedule, then to make changes to missions and anticipate the subsequent impacts. The students are given a series of dynamic changes which must be solved, during which they have access to a variety of

tools. Again, time is a factor because many of these decisions, like others in the JFAC, must be made quickly and efficiently. After successfully handling these execution challenges, the students have learned and practiced all of the skills they will need to work AAR planning and execution within the NATO JFAC staff.

The Accomplishment

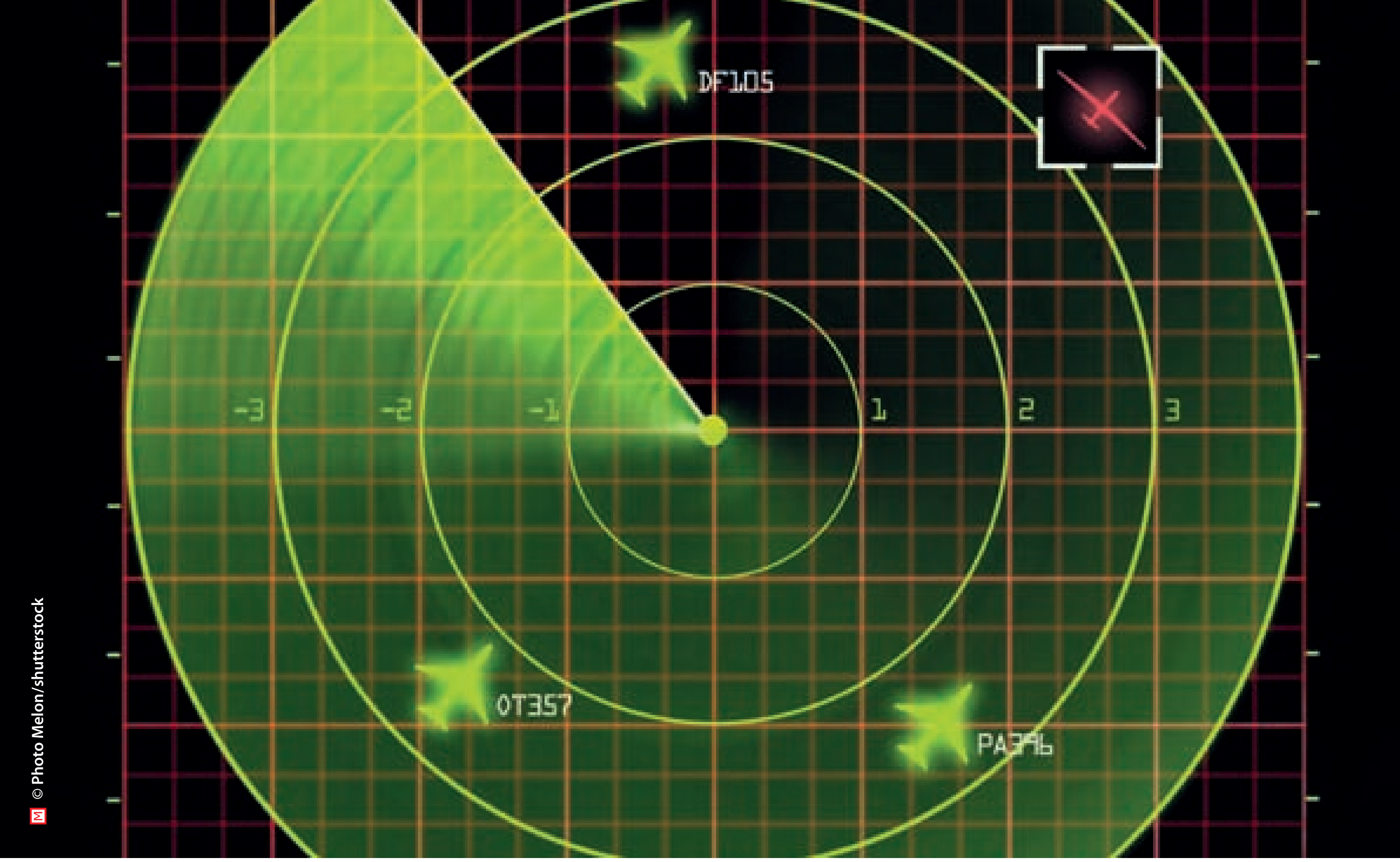
These trained individuals are a resource never before available to all of NATO. The training is designed so the graduates can integrate smoothly with US-trained individuals and vice-versa. The focus on the multinational restrictions and the diversity of the force brought in an Alliance operation makes it unique and perfectly matched for the NATO AAR picture. The course is accredited by Allied Command Transformation as 'NATO SELECTED' and is designed to become required training for assignment to AAR-specific roles within the JFAC.

This course meets NATO's need. The nature of AAR requires individuals trained and familiar with the ways our tankers and receivers operate together and with all of the challenges faced when combining Alliance tanker resources into a coherent, executable plan. Our previous operations and exercises have shown the same take-away points: planning AAR on the operational level requires unique training not provided to AAR aircrew. The SHARC brings the education and training necessary to face these challenges, addresses the Lessons Identified from OUP, and enables merging the awesome capabilities of the Alliance into a cohesive operation.



Major Joshua 'Beaker' Chambers

commissioned through AFROTC at Rochester Institute of Technology in 2002. He is a senior pilot weapons officer with more than 2,900 hours flying KC-135R/T and T-1A aircraft. He has completed operational tours in Southwest Asia, Caribbean, and Afghanistan, most recently as operations officer for forward-deployed KC-135 aircraft. Major Chambers brings a breadth of experience in squadron operations, interoperability, exercise evaluation and execution, and tanker planning and operations management. Major Chambers currently serves in the Air Operations Support branch at the Joint Air Power Competence Centre in Kalkar, Germany, where he develops NATO AAR doctrine and fosters interoperability and a unified AAR message for the Alliance.



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Remotely Piloted Aircraft Systems

Integrating Remotely Piloted Aircraft Systems into Non-Segregated Airspace

By Major André Haider, DEU Army, JAPCC
By Laura Samsó Pericón, ESP, Centurion Technologies Consulting LLC

Introduction

In recent years, Remotely Piloted Aircraft Systems (RPAS) have been the aviation industry's most dynamic growth sector and this trend is expected to continue. Market studies estimate that worldwide spending on RPAS will nearly double over the next decade, totalling almost $91 billion in the next ten years.[1] The majority of these projected investments will be attributed to the military sector, but international companies like Google, Facebook and Amazon are also running their own RPAS programmes to suit their future requirements. However, RPAS are currently only allowed to operate in a segregated volume of airspace, which is typically restricted to other airspace users in order to avoid any danger of collision. Additionally, RPAS are usually kept away from densely populated areas, so as not to endanger humans on the ground. Nevertheless, once permitted, RPAS are expected to become a significant component within any class of airspace, presently dominated by manned aviation. Consequently, the safe integration of RPAS into non-segregated airspace is currently a key issue in the military and civil aviation community.[2]

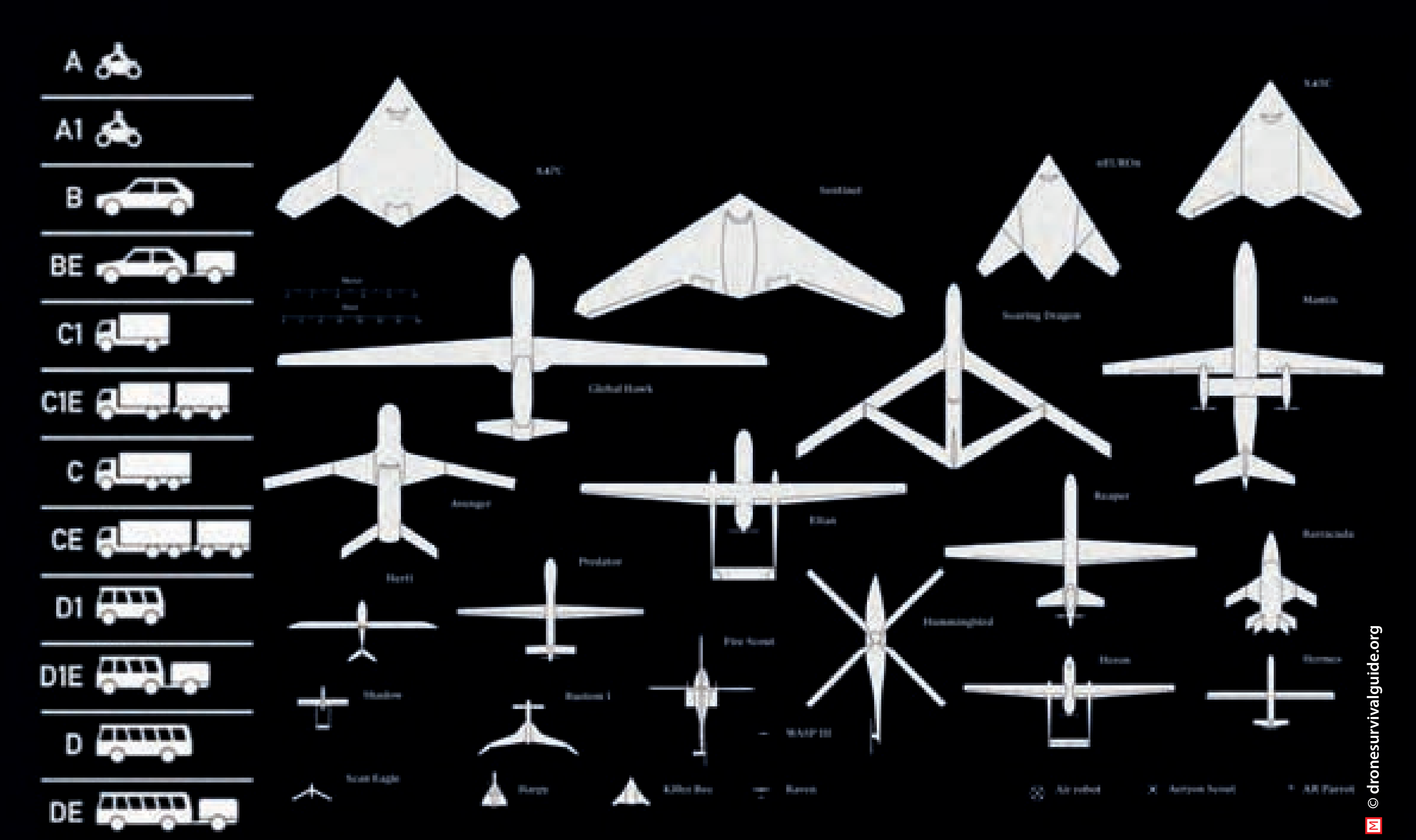


Figure 1: European vehicle classifications in contrast to the diversity of current RPAS.

There are a multitude of civil and military applications for RPAS, particularly where they appear to offer advantages, e.g. reduced risk to human personnel, extended loiter times, reduced environmental disturbance or better cost efficiency. Civilian applications may include monitoring of crops, herds, coastlines, power lines, pipelines, rivers, water reservoirs, weather or traffic. RPAS may also be of use during crime investigations, border control, aerial photography for commercial and academic purposes, logistical services or disaster control and prevention. In addition to current military applications such as intelligence, surveillance, reconnaissance, target acquisition and precision strike operations, future combat RPAS are envisioned to deliver the same performance as manned fighter aircraft and their future roles may include electronic warfare, air-to-air and air-to-ground combat. Both civilian and military applications are likely to also include research, development and testing of new RPAS, as well as education and training of their respective pilots and operators. All of the aforementioned applications eventually require RPAS to share the airspace with manned aviation. However, because the available airspace is already so congested and fragmented, vast amounts cannot simply be reserved exclusively to operate RPAS. There is, therefore, a requirement for integrating RPAS into non-segregated airspace.[3,4,5,6]

Challenges

In general, there are two main challenges related to the integration of RPAS into non-segregated airspace. Firstly, an international consensus about RPAS standards, classifications and, eventually, regulations is required. Secondly, RPAS have to ensure the same level of flight safety when operating alongside manned aircraft. In essence, there is both a regulatory and a technical challenge.

The Regulatory Challenge

The pre-requisite to integrate RPAS into non-segregated airspace is to define a set of internationally agreed classifications and standards for RPAS in order to shape the foundation for any further regulatory approach.

One good example of transnational consensus on commonly shared classifications and standards are the European Union's motor vehicles and driving licence

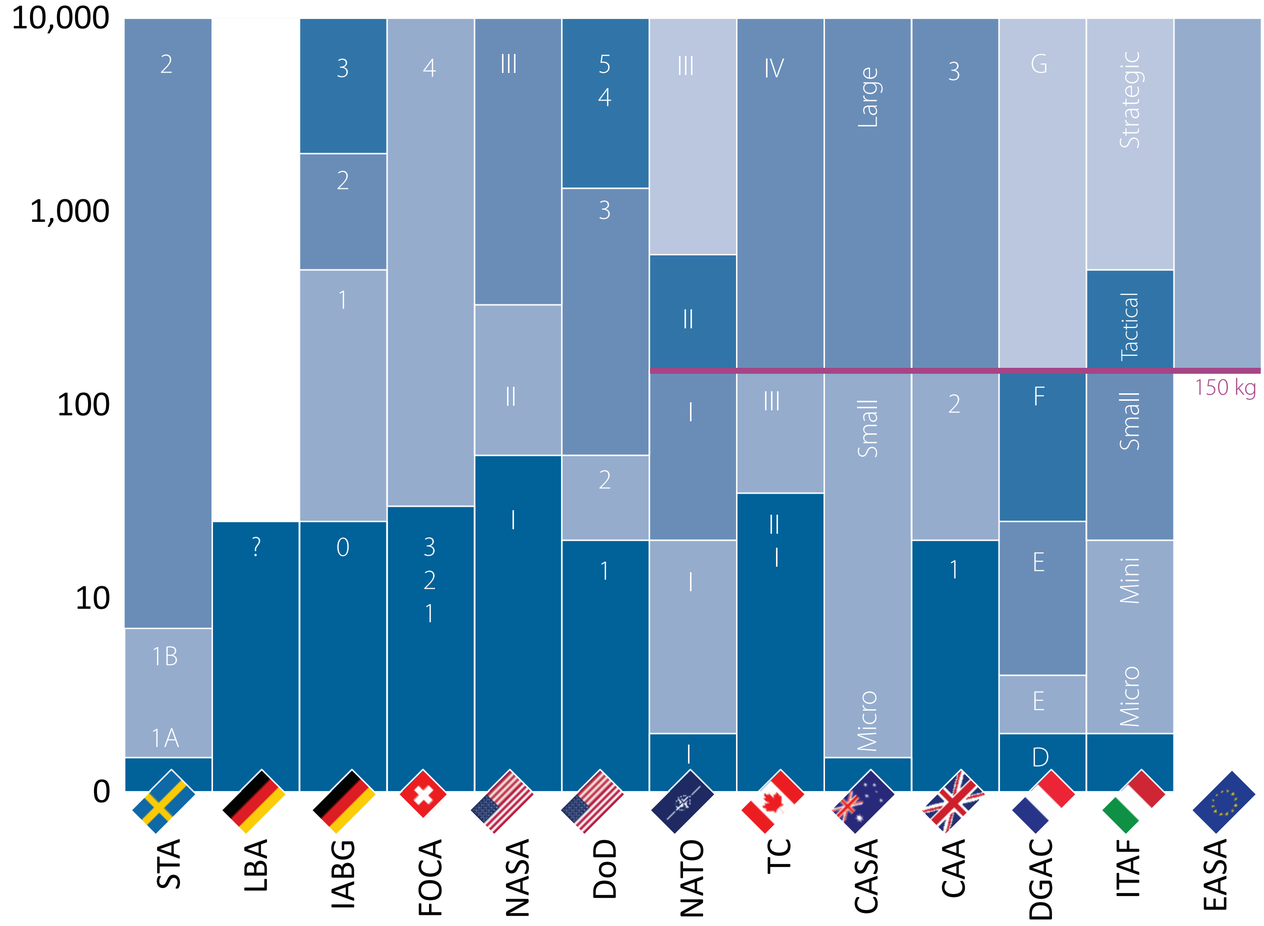


Figure 2: RPAS classifications by maximum take-off weight (kg).[7]

regulations. Civil as well as military ground vehicles in the EU are classified according to standard criteria (e.g. gross vehicle weight, number of axles, tracked or wheeled chassis, designated use for passenger or freight traffic). These classifications are the foundation for automobile engineering and production, vehicle registration, driver training and, ultimately, traffic regulations. Although the variations in design, types of propulsion as well as shapes and sizes of RPAS are

'Commonly agreed standards and classifications of RPAS are the fundamental basis of any further regulatory approach on an international level.'

significantly more comprehensive than with motor vehicles, (cf. Figure 1) this basic principle – regulation follows classification – could also be applied when trying to integrate RPAS into non-segregated airspace.

However, the current situation with RPAS is not even close to the level of standardization of motor vehicles. Almost 80 countries currently possess RPAS, whilst the number of countries running their own RPAS development programmes or actively trying to achieve RPAS technology can only be estimated.[8,9] Most of those countries have set up their own RPAS classifications, whereas only a few have adhered to already existing standards of some sort, e.g. the NATO Unmanned Arial Systems (UAS) Classification Guide.[10] Therefore, the current picture of RPAS classifications and standards is highly fragmented, formed by various types of measurements and different thresholds to distinct individual classes. Additionally, the terminology is not consistent between nations. Some nations use the phrases 'remotely piloted' and 'remotely operated' to indicate the level of qualification of the person who is controlling the aircraft, while other nations use the same terms interchangeably without any specific background or use different terminology like 'unmanned' or 'uninhabited' for their RPAS. Moreover, even within an individual nation, different RPAS classifications are sometimes established, depending on their civil, public or military application. Figure 2 illustrates an example of different RPAS classifications within some selected countries.

As with RPAS classifications, standards and terminology, national differences can be observed when considering their national airspace structures. Although most nations generally adhere to the ICAO airspace classifications, most of them do not use all airspace classes and have altered specific rules to suit their national requirements, impeding cross border operations. In consequence, the European airspace, for example, consisting of more than 50 individual national airspace structures, provides a rather fragmented picture (cf. Figure 3). The 'Single European Sky ATM Research' (SESAR) programme attempts to address this diversity, although it only aims at providing equipment standards for airspace class C, which is the most common class of airspace used in Europe. So, for the foreseeable future, the European airspace will stay cluttered and characterized by different national airspace structures.

The Technical Challenge

From a technical perspective, the challenges are to adapt and provide the technologies necessary to avoid mid-air collisions and to make RPAS technology compliant with nationally and internationally agreed aviation certification standards. Until now, there has simply been no need to incorporate such technologies, because recent (military) missions were conducted in segregated or military controlled airspace only.

In today's civil airspace, several layers of procedures and technologies are in place to ensure that the risk of mid-air collisions can be almost completely ruled out. It would require failures at multiple layers for a collision to occur.[11] In general, these layers can be subdivided into an outer and inner group. The outer layers ensure appropriate separation of aircraft, while the inner layers are aimed at actually avoiding a collision should inadequate separation occur.[12] (cf. Figure 4, p. 44)

The outermost layer consists of the basic airspace classes and procedures defined by the ICAO and individually adapted by nations. Distinct airspace classes broadly separate aircraft by ordinal altitudes and flight directions and enforce rules for operating aircraft under Instrument Flight Rules (IFR) or Visual Flight Rules (VFR). This general airspace structure also specifies minimum standards for communication equipment and pilot qualifications.

The second outer layer provides Air Traffic Management (ATM) services and separates aircraft by Air Traffic Control (ATC) instructions. This requires aircraft to be cooperative, i.e. to identify themselves and report their position to ATC by transmitting an identification signal to the ground or via traditional radio communications. Civil systems in use are the Secondary Surveillance Radar (SSR) or the more modern Automatic Dependent Surveillance-Broadcast (ADS-B) system. The military Identification Friend or Foe (IFF) is compatible with SSR and newer versions are also compatible with ADS-B, enabling military aircraft to seamlessly integrate with the civilian ATM system.

In the third outer layer, primary surveillance radars support ATC, e.g. in the vicinity of airports. In contrast to SSR receiving only active responses from aircraft transponders, primary radars track objects using their reflected radio energy. This enables them to also track non-cooperative aircraft, i.e. aircraft which do not transmit any identification signal.

If separation of aircraft fails, the inner layers should ensure collision avoidance. In the first inner layer, the transponder signals used for reporting the aircraft's position to ATC can be also used amongst aircraft to determine the position of other cooperative airspace users and give notification of potentially conflicting flight trajectories.[13]

In the second inner layer, the Traffic Alert and Collision Avoidance System (TCAS) alerts the pilot of a possible collision and suggests a coordinated manoeuvre to avoid it. TCAS is not an automated system, i.e. it still requires the Pilot in Command (PIC) to actively manoeuvre the aircraft out of the potential hazard area. Moreover, TCAS requires that both conflicting aircraft have transponders, otherwise no alert is given.[14]

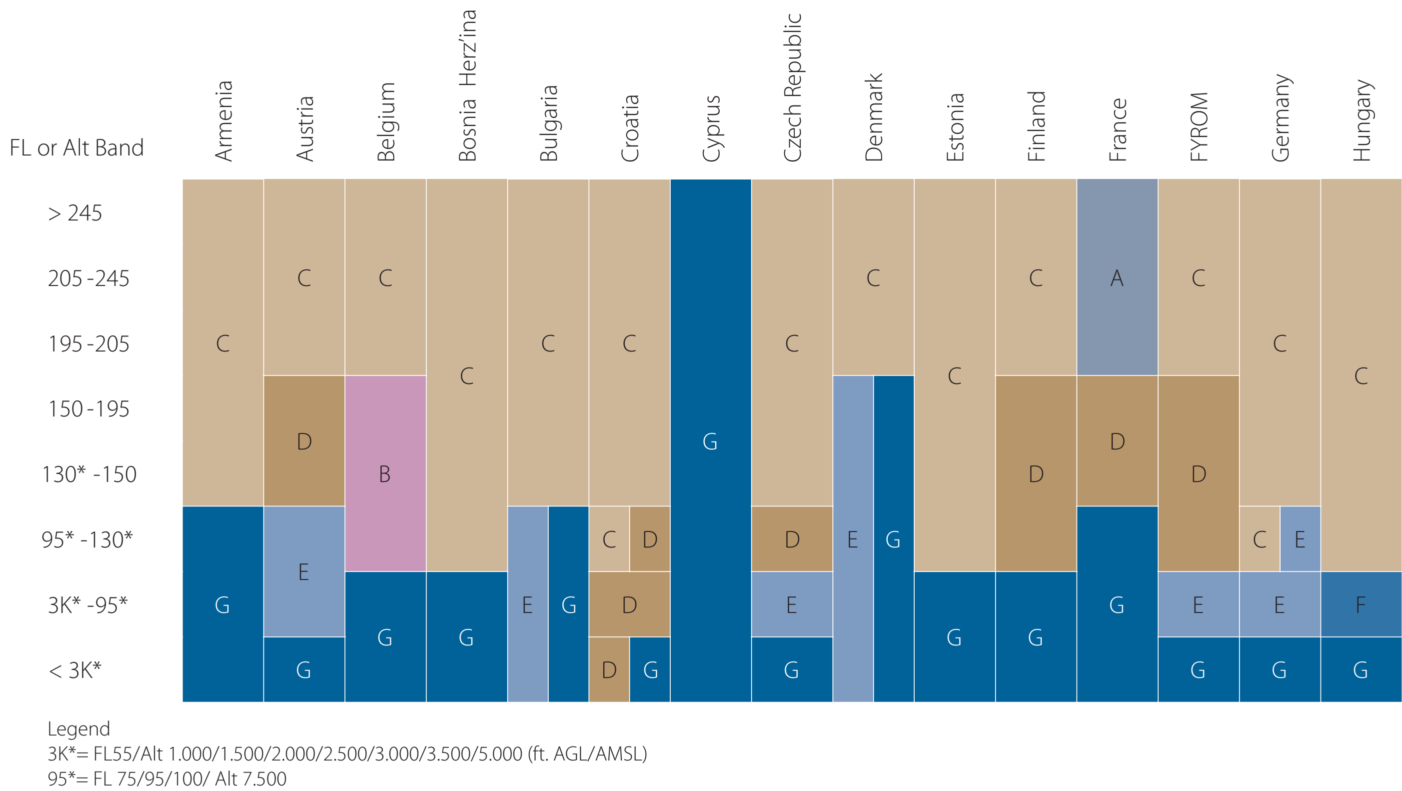


Figure 3: Airspace classes in Europe.[15]

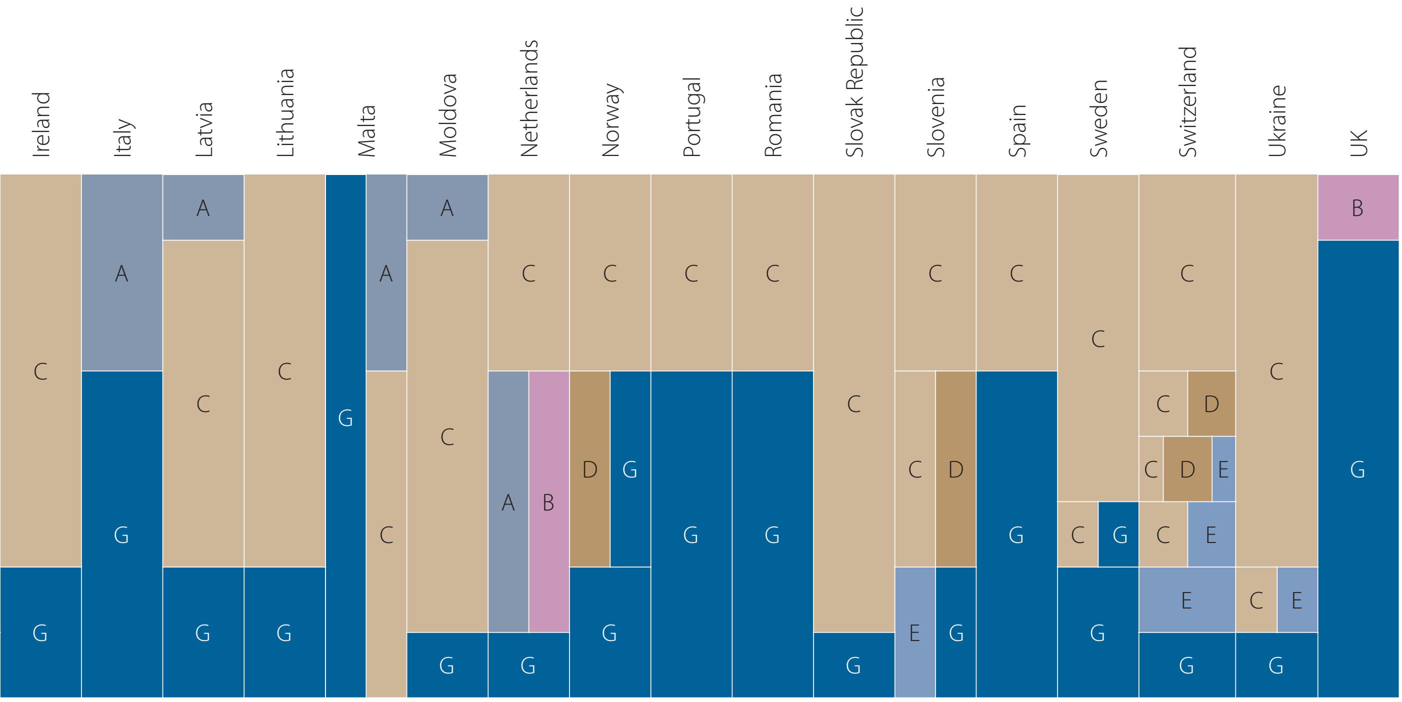
All of the previously described layers require aircraft to be cooperative, i.e. to transmit an identification signal to other airspace users and to the ATM services. Non-cooperative airspace users which do not transmit any identification signal cannot be detected unless they are tracked by primary ground radars. Most aircraft do not have primary radar on board, therefore the inner-most layer relies on the pilot's ability to literally see other non-cooperative air traffic and avoid it as necessary. This requirement is a fundamental principle of flight safety and specified in the 'Rules of the Air' laid out by ICAO Annex 2 as follows:

'An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard. […] It is important that vigilance for the purpose of detecting potential collisions be exercised on board an aircraft, regardless of the type of flight or the class of airspace in which the aircraft is operating.'

However, with regard to ICAO Annex 2 and in contrast to manned aviation, separation assurance and collision avoidance for RPAS have their own unique challenges.

Regarding separation from other air traffic, which is conducted in the three outer layers, aircraft have to be cooperative by broadcasting an identification signal, and have to be able to communicate with ATM services to follow ATC instructions. Military Medium- and High-Altitude Long-Endurance (MALE/HALE) RPAS can be expected to have an IFF transponder equipped to integrate them into military operations, so the requirements to be compliant with the three outer layers and ensuring separation of RPAS from other aircraft are basically met.

With collision avoidance it is more difficult. RPAS are controlled remotely via a Command and Control (C2) radio link between the Ground Control Station (GCS) and the Remotely Piloted Aircraft (RPA), which may even be relayed via an orbiting satellite for Beyond Line of Sight (BLOS) operations. Because there is no pilot on board the RPAS, disruption of that C2 link will result in loss of direct control of the aircraft. However, the inner layers providing collision avoidance still require the pilot to be able to actively control the aircraft to manoeuvre it out of the hazard area, since current



collision avoidance systems like TCAS do not offer any automated functions. This means that collision avoidance of RPAS is currently dependent on a reliable C2 link. At the innermost layer, RPAS lack the ability to see and avoid other air traffic because the relayed camera picture of the sensor provides only a fraction of the field of view, resolution and image depth as it would be sensed with own eyes by an on-board pilot. Additionally, the problem of C2 link disruption will also apply.

Current RPAS Detect, Sense and Avoid Developments

Currently, approved mitigation strategies include using either a ground-based observer or an observer onboard a chase aircraft. However, these solutions are unlikely to be practical for all RPAS missions. In order for routine RPAS operations in non-segregated airspace, operators must ensure that they can manoeuvre the aircraft as safely as traditional, manned aircraft pilots. As discussed, separation of RPAS from other cooperative aircraft is technically already feasible, assuming that RPAS have a military IFF transponder equipped. To mitigate or provide an alternate means of compliance to the ICAO Annex 2 'See and Avoid' regulations, two concepts are currently in development, addressing the separation and collision avoidance issue with non-cooperative aircraft. These are Ground-Based Sense and Avoid (GBSAA) and Airborne Sense and Avoid (ABSAA).

GBSAA utilizes ground-based, primary radar platforms to enable RPA operators to share common situational awareness about the relevant airspace and be alerted to potential conflict events with other aircraft. It detects airborne traffic, tracks the path of non-cooperative airspace users and provides a visualization of nearby air traffic to the RPAS operator. GBSAA also mitigates the problem of C2 link disruption by establishing an additional, independent link between the ground-based primary radar and the GCS. Because of this, the operator is always provided with an accurate trajectory of the RPA, even if the C2 link is lost. The RPA will still be out of direct human control and not manoeuvrable, but at least other air traffic can be warned and separated if necessary. However, GBSAA can only provide coordination between piloted and unmanned aircraft within limited geographic regions and air spaces.[16,17,18]

ABSAA is intended to act as a replacement for the see and avoid capability of the pilot on-board a manned aircraft, something which is unachievable with purely ground-based systems. An ABSAA system must therefore provide the same level of performance and integrity as a human pilot. Providing that level of performance in all-weather conditions, by day and night, strongly points to an on-board radar solution. Current ABSAA radars are capable of providing coverage of up to 220° in azimuth and 30° in elevation, which is roughly comparable to the field of view of an on-board pilot. However, these types of radars require a significant portion of the RPAS' available Size, Weight and Power (SWaP), which limits their use to larger systems.[19,20]

Both concepts, GBSAA as well as ABSAA, are still in development and testing and are not yet certified. The United States Department of Transportation proposed GBSAA as a short-term solution to begin operating RPAS in US airspace. The US Army also aims to conduct their MQ-1C 'Gray Eagle' training flights within the US using GBSAA.[21] Therefore it is likely that GBSAA-assisted RPAS will be the first ones to be allowed to operate in non-segregated airspace, although only as an interim solution until ABSAA systems have matured enough to be certified.

Summary

Integrating RPAS in non-segregated airspace is a complex topic, which includes airworthiness standards, pilot certifications, aviation regulations and procedures as well as technical challenges unique to remotely controlled aircraft. This document has highlighted two of these challenges, assessing them to be crucial for the way ahead and to be addressed first and foremost.

Commonly agreed standards and classifications of RPAS are the fundamental basis of any further regulatory approach on an international level. There are many national initiatives aiming to integrate RPAS into non-segregated airspace, resulting in a variety of standards and classifications. Although NATO and EU member states have jointly agreed on a common RPAS classification table for their military systems, most civil aviation authorities have not adopted them. To overcome this issue, future RPAS standards and classification have to include the civil as well as the military domain and have to be mutually agreed on by the military and civil authorities of all NATO and EU member states.

Compliance with the ICAO Annex 2 'See and Avoid' regulations is the central technical challenge which has to be addressed if RPAS are to be integrated into non-segregated airspace. The multi-layered approach (separation of aircraft on the outer layers and collision avoidance on the inner layers) must be complemented by an RPAS-specific 'core' layer, e.g. providing pre-defined evasive flight manoeuvres in case of delayed human responsiveness, signal latency or disruption of the C2 data link. GBSAA systems may support the integration of RPAS into non-segregated airspace, but they are limited to a specific geographical area, depending on their radar coverage. Additionally, GBSAA systems only provide situational awareness to separate RPAS from other aircraft; they cannot provide collision avoidance. Conclusively, collision avoidance of RPAS will eventually require an automated ABSAA system, intended for such cases where active control of the aircraft is lost (Figure 4). Finally, RPAS which cannot be fitted with an ABSAA system due to their SWaP restrictions and cannot therefore be compliant

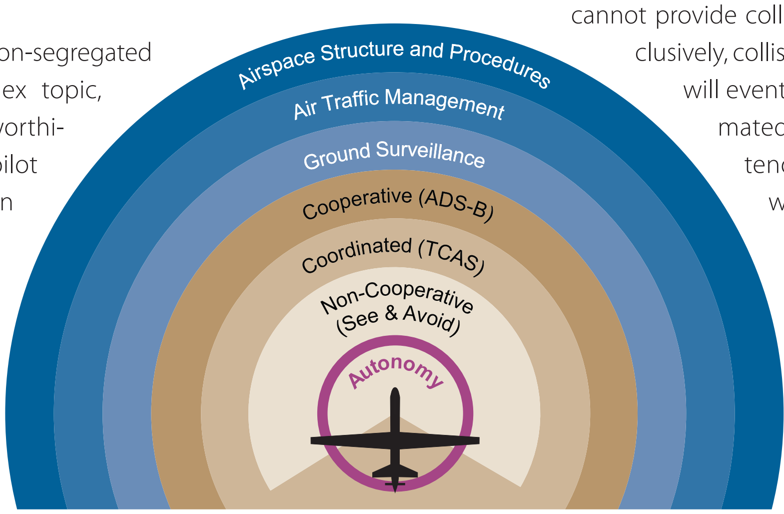
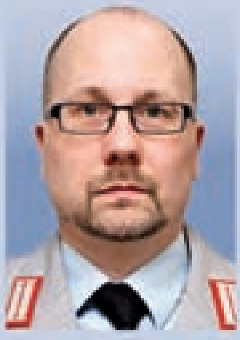


Figure 4: Aircraft separation and collision avoidance layers.[22]

with the ICAO Annex 2 'See and Avoid' regulations will still have to be confined to a segregated volume of airspace or have to stick to current regulations for model aircraft, preventing them from interfering with other airspace users.

Despite many advances, RPAS are still in their infancy. The current state of development is often compared to the point at which the Wright Flyer first took to the air in 1903. Academia, industry, regulatory authorities as well as the military are working diligently to integrate RPAS into the civilian airspace. The time has now come to combine these efforts.

1. 'World Unmanned Aerial Vehicle Systems, Market Profile and Forecast 2014', Teal Group, 2014.
2. 'FAA Aerospace Forecast Fiscal Years 2014–2034', Federal Aviation Administration (FAA), 2014.
3. 'Economic Impact of a Pan-Pacific Unmanned Aircraft Systems Test Site', McDowell Group, May 2013.
4. 'Mitigation of Airspace Congestion Impact on Airline Networks', Bo Vaaben & Jesper Larsen, Technical University of Denmark, 2013.
5. 'Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System', Final report from the European RPAS Steering Group, Jun. 2013.
6. 'Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap', US Department of Transportation, Federal Aviation Administration, First Edition 2013.
7. 'Perspectives on Unmanned Aircraft – Classification for Civil Airworthiness Standards', Jeffrey M. Maddalon, Kelly J. Hayhurst, Daniel M. Koppen, Jason M. Upchurch, and A. Terry Morris, Langley Research Center, Hampton, Virginia, NASA/TM–2013-217969, Feb. 2013.
8. L. Brooke-Holland, Unmanned Aerial Vehicles (drones): an introduction, UK House of Commons, 2013.
9. US Government Accountability Office (GAO), NONPROLIFERATION – Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports, GAO, 2012.
10. NATO Joint Capabilities Group Unmanned Aircraft Systems (JCGUAS), 2009.
11. 'Unmanned Aircraft Collision Avoidance – Technology Assessment and Evaluation Methods', Andrew R. Lacher, David R. Maroney, Dr Andrew D. Zeitlin, The MITRE Corporation, McLean, VA, USA.
12. 'On Integrating Unmanned Aircraft Systems into the National Airspace System', 2nd Edition, K. Dalamagkidis, K.P. Valavanis, L.A. Piegl, Springer Science+Business Media B.V., 2012.
13. ADS-B uses transponder signals to broadcast an absolute position to ground-based controllers and other aircraft, providing a cooperative position. TCAS coordinates with other aircraft based on relative position and vector to ensure no collision occurs as long as system inputs are followed by pilots.
14. 'The Traffic Alert and Collision Avoidance System', James K. Kuchar and Ann C. Drumm, Lincoln Laboratory Journal, Volume 16, Number 2, 2007.
15. 'EUROCONTROL Airspace Strategy for the ECAC States', Airspace Classifications post 31 Jan. 2005, Bill Armit, Simplification of European Airspace Classification Project Manager.
16. US Army, 'Army radar to allow UAS to fly in National Air Space', 2 Jul. 2012, Available Online: http://www.army.mil/article/82989/Army_radar_to_allow_UAS_to_fly_in_National_Air_Space/.
17. US Army, UAS Project Office, 'Unmanned Systems Airspace Integration Concepts (USAIC)', Available Online: http://usarmy.vo.llnwd.net/e2/c/downloads/254537.pdf.
18. IHS Jane's, 'US Army to install ground-based UAV radar at five sites by 2016', 13 Jan. 2014, Available Online: http://www.janes.com/article/32294/us-army-to-install-ground-based-uav-radar-at-five-sites-by-2016.
19. MIT Lincoln Laboratory, 'Airborne Sense and Avoid Radar Panel', TechNotes, Oct. 2014, Available Online: http://www.ll.mit.edu/publications/technotes/TechNote_ABSAAPanel.pdf.
20. Ted Lester, Dr Steve Cook, Kyle Noth, MITRE Corporation, 'USAF Airborne Sense and Avoid (ABSAA) Airworthiness and Operational Approval Approach', 31 Jan. 2014.
21. 'US Army begins installing common ground-based sense-and-avoid radar', Marina Malenic, IHS Jane's Defence Weekly, Washington, DC, Available online: http://www.janes.com/article/47002/us-army-begins-installing-common-ground-based-sense-and-avoid-radar.
22. Ibid. 12.



Major 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.

Laura Samsó Pericón

MSc in Aerospace Science and Technology from Polytechnic University of Catalonia and BSc in Telecommunications Engineering (Electronics) from La Salle – Ramon Llull University. She is currently pursuing PMP certification. Position that builds on more than 14 years-experience as project/program manager, team manager, business developer, systems engineer and researcher contributing to national and international projects dealing mainly with geomatics applications, manned and unmanned aircrafts, and Earth Observation satellite systems. Laura is currently an international speaker at Centurion Technologies Consulting LLC in US and a business developer at Elecnor Deimos in Spain. She is contributing to current policy regarding implementation of RPAS in European and American airspaces.

Figure 1: Simulated population of objects greater than one centimetre on all Earth orbits.

A Model of the Space Debris Environment

The Scientific Research Concerning Particle Fluxes on Satellites

By Dr. Carsten Wiedemann, Institute of Space Systems, TU Braunschweig

Since the launch of Sputnik in 1957, space debris has accumulated on earth's orbits. About 17,000 larger objects are tracked by the US Joint Space Operations Center and their orbital data made available to the public. However, there is a much larger number of smaller objects not tracked or not trackable. The increasing amount of space debris represents a risk for satellite missions. Depending on the size and the relative impact velocity of objects, collisions could cause considerable damage to satellites. In some regions, the spatial debris density is already so high that a collision would result in a cascading effect, known or referred to as the 'Kessler Syndrome'. In this article, the fundamental problem of the space debris environment is presented. A particular focus is placed on the statistical modelling of space debris which is not visible from earth. This model forms the basis for estimating the risk of collision between particles and space vehicles.

State of Knowledge

Space debris is already an important part of the space environment which must be considered during planning and operation of a satellite or constellation of

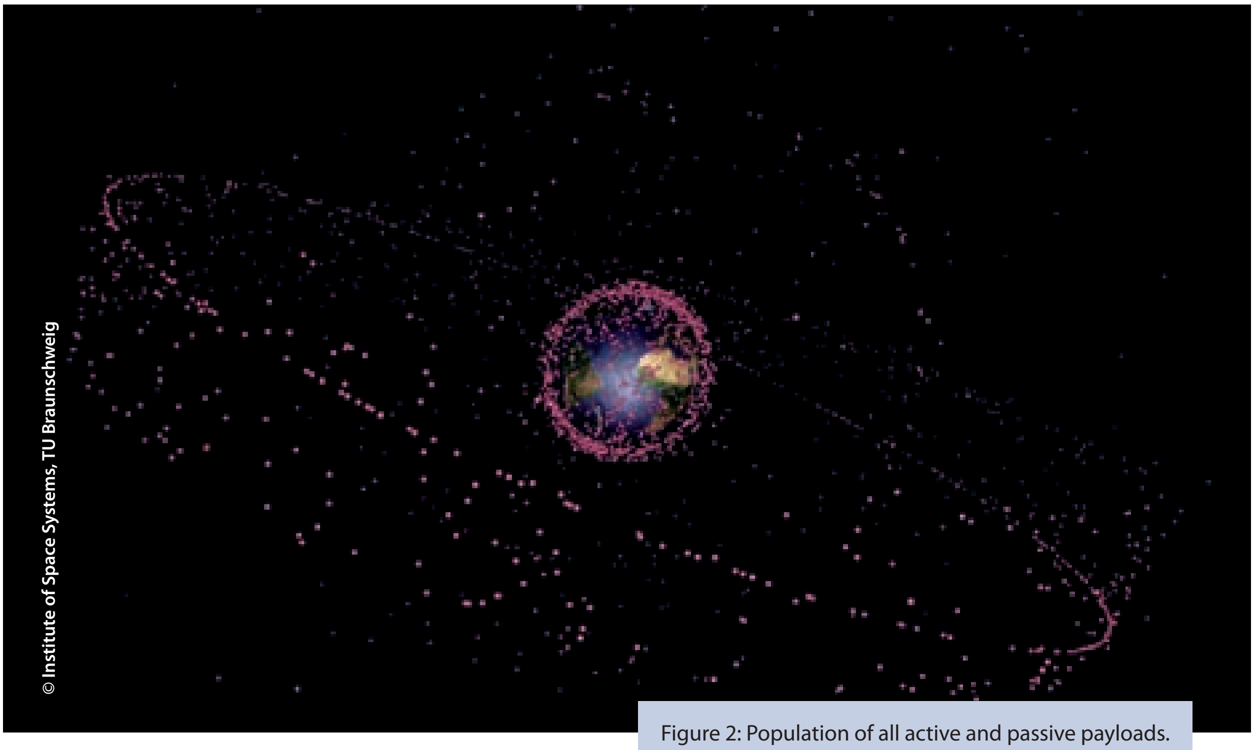


Figure 2: Population of all active and passive payloads.

satellites. If larger objects are approaching the satellite, it is sometimes necessary to perform avoidance manoeuvres. The orbits of larger objects, those greater than ten centimetres, are tracked using ground based sensors. The orbital data catalogue maintained by USSTRATCOM contains only a small amount of the actual space debris population. The number of smaller, untrackable objects is very high. The population of submillimetre sized objects is derived from the analysis of impacts on retrieved satellites and, therefore, knowledge about the small particle population is limited to the orbit and the time span when these spacecraft were on orbit. Clearly, such a measurement regime does not provide a complete picture of the debris population. The total number of particles and their orbits cannot be determined solely from measured data. This information must be estimated by a model.

Space Debris Model

A model called MASTER-2009[1] has been developed at the Technical University (TU) of Braunschweig on behalf of the European Space Agency (ESA). This model reasonably predicts the particle flux for all orbits up to an altitude slightly above the geostationary orbit. The particle flux quantitatively indicates the number of particles that strike the surface of a satellite over a one year period – a normalized surface measure of one square metre is used. Measured data are used to validate the model. This modelling approach indirectly gives a good estimation of the expected particle count over a specified timeframe.

What is involved in modelling? At the TU Braunschweig a very sophisticated approach has been chosen. Every space debris-generating event ever documented in the history of space flight is simulated within the model. A forecasted debris cloud is generated which encompasses all particles larger than one micron in size. During a fragmentation event, each simulated piece of debris is assigned to its own orbit. Taking into account all perturbing forces that can occur in outer space, the orbits of these objects are propagated to a reference epoch. A huge debris population is represented for which orbital parameters are assigned to each particle. From this population, particle fluxes on satellite-based surfaces can be predicted. The model estimates many debris characteristics and parameters including: how many particles, from which direction they will impact a satellite, with what speed, and the size class.

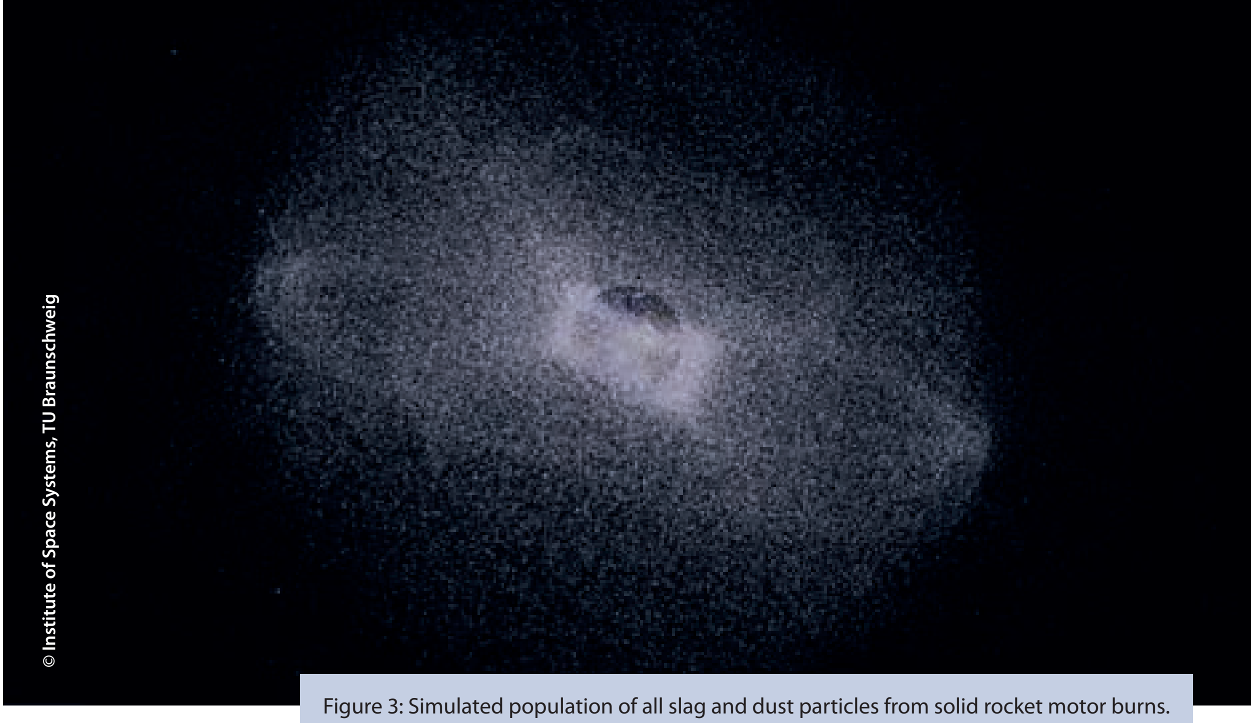


Figure 3: Simulated population of all slag and dust particles from solid rocket motor burns.

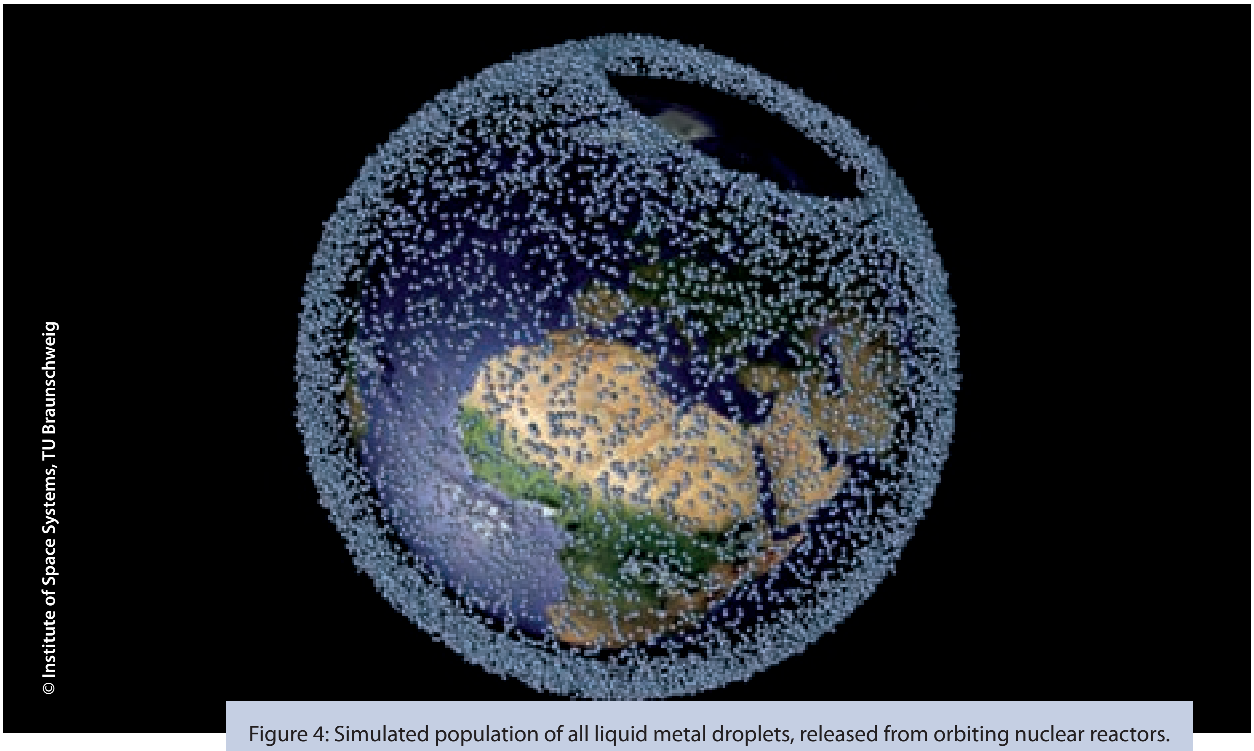


Figure 4: Simulated population of all liquid metal droplets, released from orbiting nuclear reactors.

Scientific Research

The scientific challenge in the design of the MASTER 2009 model was threefold. First was consideration of higher orbital mechanics; the theory of orbital perturbations, necessary to represent the dynamic behaviour of debris distributions around the earth. Perturbing forces cause changes to the shape and the orientation of orbits. The second scientific task involved the understanding of and consideration for all known space debris sources. There exist many different sources of space debris which uniquely and/or differently contribute to specific orbits or specific debris components. For example, objects larger than one centimetre are predominantly the result of fragments from spacecraft explosions or collisions. The second largest source is slag particles from solid rocket motors. Furthermore, a very unusual source of space

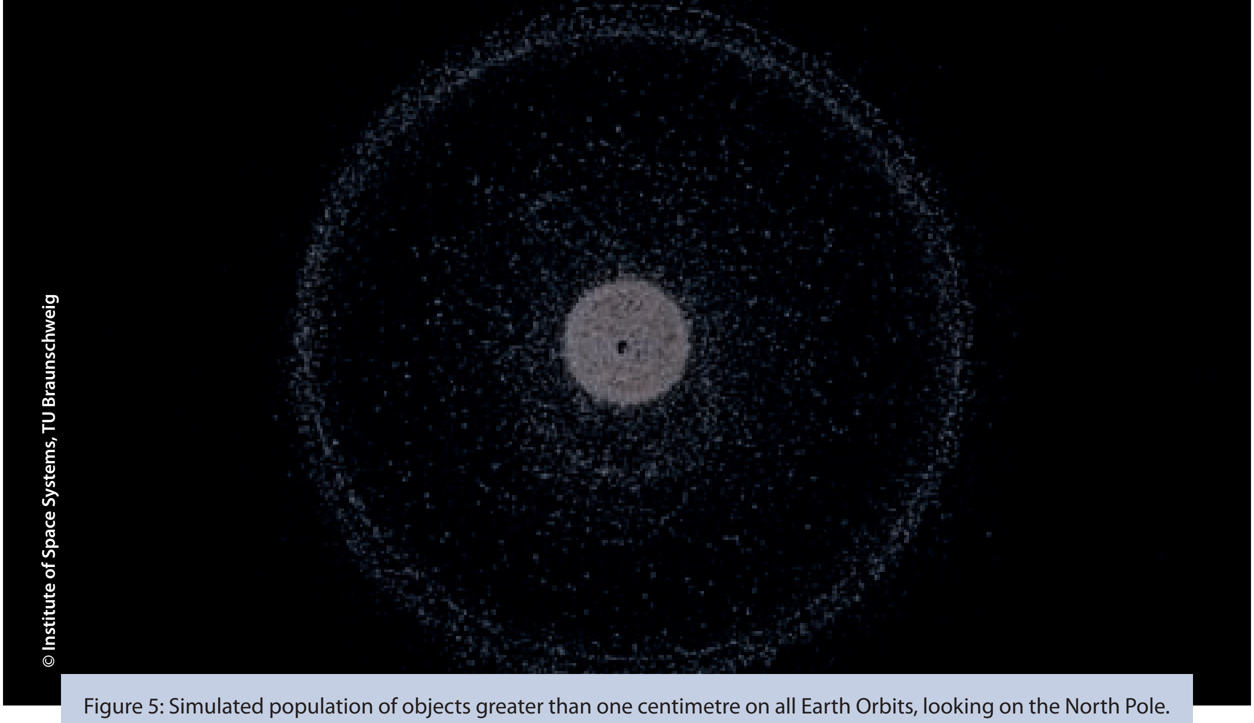


Figure 5: Simulated population of objects greater than one centimetre on all Earth Orbits, looking on the North Pole.

debris was observed that occurs only at 900 km altitude; liquid metal droplets which have been released from the cooling systems of space-borne nuclear reactors. Space debris less than a millimetre in size originates predominantly from other sources. For example, in the 100-micron class, the majority of particles on Low Earth Orbit (LEO) are so-called 'ejecta': particles generated by smaller space objects or micrometeorites impacting or colliding with larger debris or even satellites. Such collisions produce small craters, from which material is ejected. Their number is so high because they are permanently produced. The next dominant source of debris in this class is paint flakes, which continuously erode or flake away from spent rocket upper stages or satellites. Our research shows that every debris source has its own release mechanism, each based on unique or specific physical effects. These release events must be described by different models or model elements which are integrated. Only then it is possible to model the complete particle environment predictably with reasonable accuracy.

The third scientific challenge is to validate the modelled space debris environment using measured data and newly discovered debris sources. The aim is to achieve that the observed space debris environment is accurately reproduced by the model, a goal which requires many years of experience and continuous collection empirical data. Each source must be researched carefully, with their release or fragmentation mechanisms understood and modelled so to agree with the observations.

Model Estimations and Findings

The most important estimations stemming from our research in the field of space debris and the development of the model are summarized below:

1. About 29,000 objects larger than ten centimetres are on earth orbit.
2. The number of objects greater than five centimetres is approximately 60,000.
3. About 700,000 objects larger than one centimetre orbit the earth.
4. The millimetre population is close to 200 million particles.
5. The number of sub-millimetre class particles is in the order of magnitude of some trillions.

Perhaps the most important finding was that the orbits facing the highest risk of collision today range from 800 km to 900 km in altitude. In almost all size classes, the largest quantity of objects occurs in this altitude band. This means that those space vehicles operating in these orbits are exposed to the highest risk of collision. The orbits at 800 km altitude are especially important for earth observation missions, since they are used by sun-synchronous satellites.

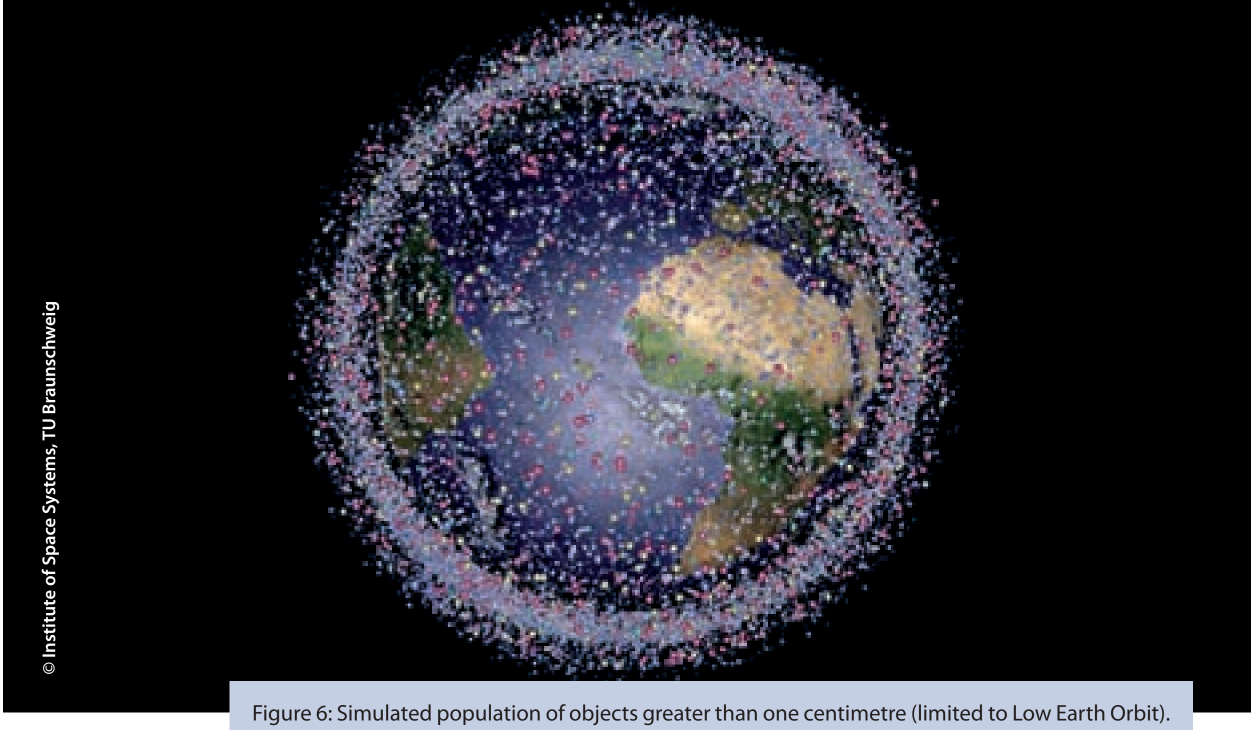


Figure 6: Simulated population of objects greater than one centimetre (limited to Low Earth Orbit).

Most avoidance manoeuvres must be performed at these altitudes. This orbital altitude requires special attention in terms of space situational awareness activities.

Besides the high probability of collision, simulations revealed that the spatial density of debris at the altitude close to 800 km is so high that a collisional cascading effect is plausible. This type of fragmentation event is called a 'catastrophic collision'. The debris generated during such a collision could again trigger a new catastrophic collision and so on. Considering a typical LEO collision velocity of ten kilometres per second, an object with a diameter of ten centimetres has enough kinetic energy to completely destroy a spacecraft. This could result in a self-driven or cascading effect releasing further space debris, an effect known as the Kessler-Syndrome. A principle cause for concern is larger spent spacecraft with long remaining orbital lifetime and their potential for collision with large elements of debris.

Conclusion

To date, catastrophic collisions have not significantly contributed to debris generation. They occur, statistically, about every five to nine years. However, as the number of objects continues to accumulate on orbit, such collisions become more likely. The ability to model the space debris environment is not only a necessary scientific step to close space observation gaps, but it also provides an avenue to create awareness about the expected evolution of the risk to operating in space in the future.

1. Space Debris User Portal, https://sdup.esoc.esa.int.

Dr.-Ing. Carsten Wiedemann

is a permanently employed senior scientist at the Institute of Space Systems at the Technische Universität Braunschweig (Germany). His responsibilities include: quality manager of the institute, team head of the space debris group, organization and presentation of lectures, supervision of student research projects, and scientific project work. He is member of the delegation of the German space agency at the Inter-Agency Space Debris Coordination Committee (IADC). His field of research is modelling of the space debris environment. His development and upgrading of the ESA MASTER (Meteoroid and Space Debris Terrestrial Environment Reference) model constitutes important research and endeavor in the field of Space.

Doing the Same with Less – Potential Synergies for NATO Air Power

By Lieutenant Colonel Pascal Gremez, BEL AF, JAPCC

Defence budget constraints across all NATO nations point to an overall reduction in defence capability. This article examines ways in which NATO Air Power could overcome this challenge.

Introduction

While the fight against DAESH[1] is conducted through a 'Coalition of the Willing', there are no ongoing large-scale NATO-led operations. Additionally, though the exact outcome of the Ukraine crisis is still unknown, the recent temporary increase of Air Policing along the eastern borders of the Alliance was not planned, at least not initially, to become a long lasting endeavour. This implies that the Organization will transform from a wartime, combat posture, towards an era in which education, training, and exercise will probably be the main focus in maintaining NATO's military preparedness and readiness for the coming years.

While geopolitical threats are shifting fast, most military budgets remain restricted by post-recession austerity policies. The global economic crisis has put pressure on national budgets and consequently restricted defence spending. One implication of this is that political decision-makers are re-focusing spending only on essential core business activities within each national department whilst minimizing budget allocation for so-called 'non-essential' domains of activity.

The overall availability of military capabilities within NATO nations will almost certainly be affected between now and the medium term. This may mean that some specific capabilities may no longer be available for operations or only available for a shorter duration. As clearly explained in the JAPCC Future Vector Project, few nations focus on a broad spectrum of capabilities, with most NATO members tending to focus on capability developments based on a strategy of capability oriented planning. This leads to a tailored set of defence capabilities and competencies, which implies that interdependencies between nations exist and will continue to exist. In order to be successful in addressing future crises and conflicts, NATO should, therefore, require a guaranteed 'commitment to deliver' by its member nations, which will reinforce the will to provide the necessary core competencies. So far however, a guaranteed 'commitment to deliver' is far from being politically feasible.

Consequently, one can question whether NATO member states will be able to retain appropriate military capabilities and properly train sufficient personnel to assign to NATO in the future.

Future Scenarios

In a 2014 study, the UK's Development, Concepts and Doctrine Centre (DCDC) suggested that: *'the future character of conflict will result in what some have called wicked, unbounded or insoluble problems. Attempts to solve these using a single institutional framework designed for tame, bounded and soluble problems are almost bound to fail. In wicked problems, there is no clear relationship between cause and effect and no single institution will be able to control the outcome. The principal skill will be the art of leadership required to persuade necessarily large communities of interest to face up together to those complex problems that defy scientific management approaches; wicked problems beg comprehensive responses.'*[2]

Nobody can really predict the future, except to say it will remain uncertain. Typically, the emergence of supranational terrorist organizations will drastically increase the complexity of the task assigned to traditional armed forces of neutralizing them. We can also expect the nature of conflict to continue to change because of technology. As people become more connected and dependent on technology, the potential for inflicting significant harm on an adversary without the need for violence is likely to increase. Globalization is likely to provide opportunities for actors to create social and political instability.

Future scenarios may present so-called 'hybrid warfare' challenges, in which the lines between various types of conflict may be blurred, with a mix of traditional and irregular war, terrorism, and a greater emphasis on the battle over the narrative. This kind of scenario would further require organizations like NATO to place the emphasis on a so-called comprehensive approach through in-depth cooperation and coordination with non-military organizations.

As the nature of future conflict is hard to predict, a complete set of Air Power capabilities in the fields of Combat and Combat Support will need to be maintained. Continuous training for the full spectrum of air warfare remains our unique guarantee that Air Power will remain relevant and able to face any kind of crisis. NATO may need to plan and prepare managing fewer available resources but with no foreseeable reduction in actual demand.

A Greater Role for European Air Power within NATO

In June 2014, the NATO Secretary General, Anders Fogh Rasmussen, declared that 'Russia's illegal aggression against Ukraine has made the security environment in Europe unpredictable and dangerous. Russia has increased defence spending by fifty percent over the last five years, while the allies have reduced theirs

by a fifth.' Rasmussen warned NATO members that they will have to pay for measures that must be continued 'as long as necessary'.[3] He asked nations to further increase their spending when the economic situation would permit.[4] However, whilst this might convince some NATO member nations to freeze defence budgets until the situation in Ukraine is stabilized, the current economic situation may drive them to maintain additional budget reductions in their medium term agenda. Only a small group of NATO nations have effectively committed themselves to meeting the 2 % of GDP level for defence spending, as was reiterated during last year's NATO Summit in Wales.

Whilst the American economy has recovered from the 2008 crisis, the consequences of the sequestration process could strongly influence the shaping of US forces during the next decade. Consequently, one of the main changes is the shift from a 'Win-Win' towards a 'Win-Deny' strategy for US Defence forces, to include an increased reliance on European armed forces to cover the gap induced by the decrease in US capability potential. A greater role for European Air Power may be required and European nations should be prepared for this.

When faced with the same requirements but diminishing resources, there is an increased need for both the US and Europe to jointly consider how best to address these potential shortfalls whilst searching for possible synergies.

The Way Forward: The Need for a Holistic Approach Through Synergy

Synergy implies that the result of the combined effect should be greater than the result of two separate actions. Another possible understanding of this definition could be the use of fewer resources in a more effective and cooperative way should lead to the same goal. In military terms, a synergistic approach could mean that NATO Air Power might be able to fulfil its assigned tasks with reduced assigned capabilities if it operates in a different, perhaps more efficient way.

Without doubt, further increased efficiency in the ways of using available resources will be required. Prioritization, cooperation and effectiveness will become key throughout the entire equipment lifecycle, from the start of the acquisition phase until the end of their effective use in operation. This should start in the acquisition phase, during which managers must ask themselves whether synergies may be found between services or within the same service. Subsequently, even though it may require additional efforts to overcome potential national reservations or to address legal issues, exploring multinational cooperation must be considered as a potential source of synergies resulting from larger scale acquisitions. Finding synergies with internal or external partners in order to reduce costs must become an integral part of every programme. This may require clear directives to set-up the correct priorities and to overcome the 'corporatism' or other cultural barriers that are sometimes encountered in large organizations.

Operational planning. Even though this may already be the case, operational managers must continue to look for synergies and decide upon the most optimal use of their assigned capabilities. As we may anticipate some reductions in terms of capabilities, operational planners must look further into ways of maximizing and optimizing the use of the available resources. This may take place in two ways: firstly, a better knowledge of the real potential for cooperative use of assets, and, secondly, optimizing effects-based targeting with a careful choice of the assigned capabilities.

The result of this should be improved selection of the capability best-suited to achieve the assigned objective. Increased pressure on operational planners will inevitably push them towards looking for the 'best pay-off' for every situation. This is likely to require an increased effort in education and training.

From multi-role to multi-mission. This emerging concept makes it possible to achieve synergy through the simultaneous use of a single platform for multiple missions where previously two or more platforms would have been required. Some such initiatives already exist. However, the degree of influence of one role on another role's performance implies that it may not be considered as a true multi-mission platform.

In the domain of Air Combat, 5th generation and future upgraded versions of so-called '4.5 generation' aircraft are claimed to be designed to allow them to conduct a variety of missions simultaneously in a contested environment. Similarly, Defence industry must conceptualize and develop future platforms, manned and unmanned, to become truly 'multi-mission'. The potential exists to develop future Remotely Piloted Aircraft Systems (RPAS) that are able to conduct multiple missions during the same sortie. Any combination including two or more of the Imagery, Surveillance and Reconaissance (ISR), Electronic Warfare (EW), Transport or Air-to-Air Refuelling (AAR) roles should provide future Air Operations Commanders with increased flexibility whilst also capitalizing on the persistence offered by unmanned platforms.

'NATO should, therefore, require a guaranteed "commitment to deliver" by its member nations … However, so far, a guaranteed "commitment to deliver" is far from being politically feasible.'

Multinational construct. The NATO E3-A Component, the C-17 Heavy Airlift Wing and the NATO Alliance Ground Surveillance (AGS) are examples of efficient multinational constructs. The E3-A and the Heavy Airlift Wing proved their cost-effectiveness by allowing nations to pool resources in order to provide NATO with an appropriate solution to mitigate a capability gap. Today, as the cost of high-tech assets is increasing at a higher rate than inflation and as defence budgets are decreasing, the only option nations have is to buy less equipment or refrain from buying altogether. Since some nations are now struggling to find the financial resources needed to replace legacy equipment, the creation of such multinational units should be seen as one of the possible ways ahead. One might argue that issues of responsibility and sovereignty may hamper such a concept when it comes to fielding multinational units in the Air Combat Operations arena. However, it is surprising what can be achieved once the political will exists.

Training scenarios. NATO training scenarios also need to acknowledge the lack of capabilities. At the leadership level, NATO must train in circumstances where judgment and risk assessment will become key

'The gap induced by the decrease in US capability potential may require a greater role for European Air Power and European nations should be prepared for this.'

to providing planners with proper direction. The use of simulation training capacities should increase the overall quality of training. The mantra of 'train hard to fight easy' should perhaps be replaced by one of 'train hard, then train harder'.

Conclusions

A reduction in defence spending will always be an 'easy win' for politicians looking for ways to make savings. Resources, including financial ones, are finite and compromises will continue to be required.

'Fight like you train' will remain even more valid tomorrow than it has during recent decades. In order to assure the success of future operations, all NATO personnel involved in operational planning must concern themselves with maximizing the output of operational capabilities. Key to any success will be adequate training in challenging scenarios where the overall availability of operational resources may not meet the anticipated requirements. Ensuring high quality training for its personnel will help NATO to maintain the ability to cope with future peer competitors and to cover a broader spectrum of tasks whilst anticipating a lack of resources.

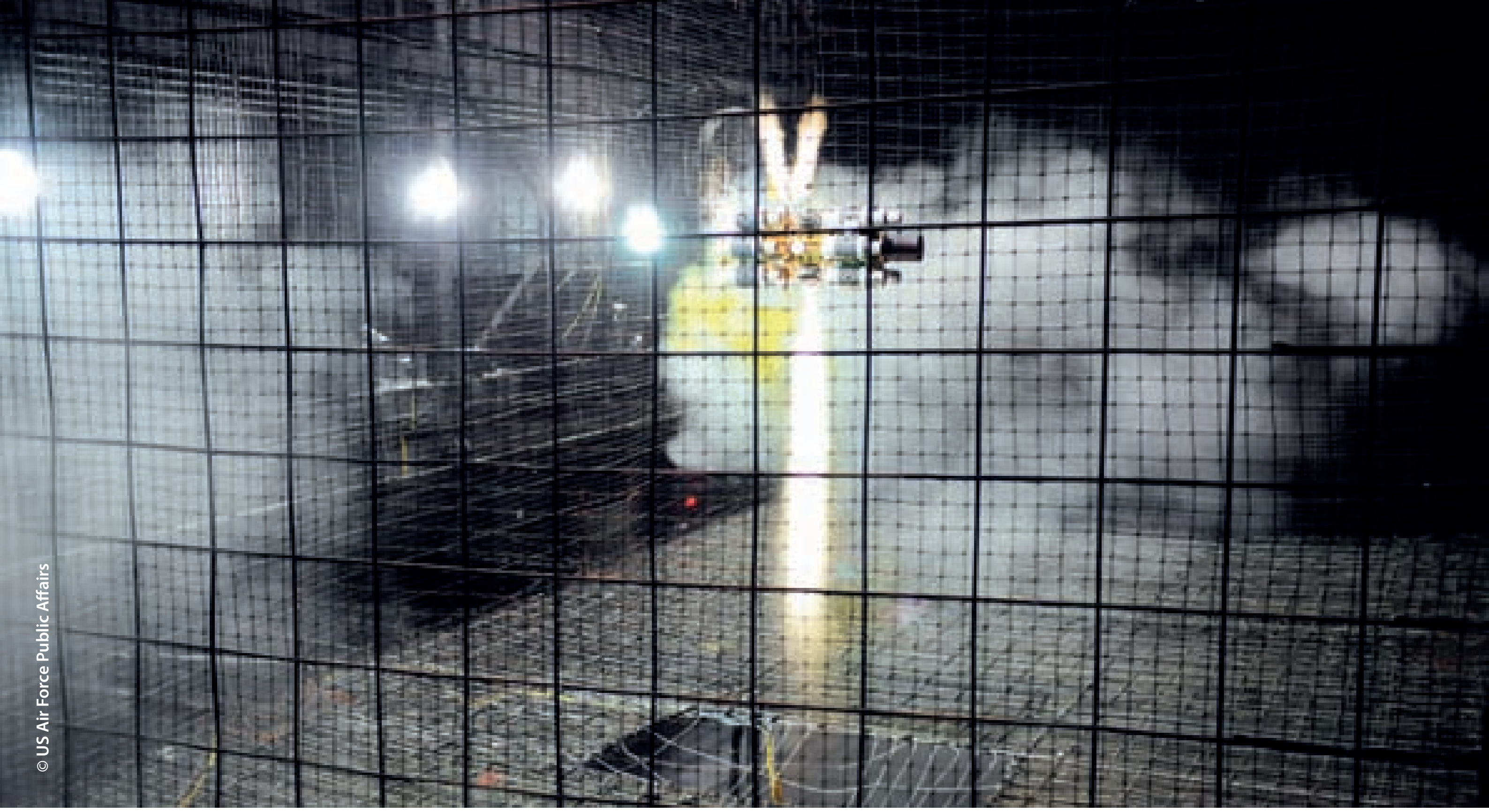
However, a war cannot be won without adequate material and military spending cannot be cut indefinitely. Nations, who are the owners of most of NATO's inventory, will play a key role when it comes to selecting and introducing new capabilities into service. 'Multi-mission' and 'Multinational' may become the only way to overcome the budgetary constraints that nations will continue to face in the years to come.

Sovereignty and liability issues may prove difficult to overcome when it comes to establishing the concept of multinational combat units. Nevertheless, this should be considered at the political level as one potential solution to overcome reduced resources. This will, no doubt, require political willingness amongst pioneer nations and a top-down approach.

1. 'ad-Dawlah al-Islāmīyah fī al-'Irāq wash-Shām', the Militant group which Identifies itself as the Islamic State (IS).
2. DCDC, 'The Future Character of Conflict', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/33685/FCOCReadactedFinalWeb.pdf, p. 38.
3. 'Russia, friend or foe for NATO?', BRUSSELS, 5 Jun., 2014 (AFP), http://www.defencetalk.com/russia-friend-or-foe-for-nato-59771.
4. 'The Future of NATO: A Strong Alliance in an Unpredictable World', Anders Fogh Rasmussen, 19 Jun. 2014, http://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20140619Rasmussen.pdf.

Lieutenant Colonel Pascal Gremez

is an experienced Air Operations Officer currently assigned to the JAPCC in the Combat Air Branch as a Combat aircraft SME. Lieutenant Colonel Gremez is a fighter pilot of the Belgian Air Force with almost 2,000 hours on the F-16. His previous assignments include the 2 Tactical Wing (FLORENNES AB) as Flying Group Commander, the Staff of the Belgian Air Component Command and the Belgian Defence College.



Platform Autonomy

State-of-the-Art and Future Perspectives from an S&T Point of View

By Dipl.-Ing. Hans-Ludwig Besser, DEU, Technical Director (ret.) Bayern-Chemie GmbH, Subsidiary of MBD.A Missile Systems
By Dr.-Ing. Dennis Göge, DEU, Executive Board Representative and Programme Coordinator Defence and Security Research, German Aerospace Center (DLR)
By Mr Michael Huggins, USA, Chief Space and Missile Propulsion Division, Air Force Research Laboratory (AFRL)
By Dipl.-Ing. Dirk Zimper, DEU, Executive Officer AVT Panel, Collaborative Support Office (CSO) of NATO's Science & Technology Organization (STO)

Foreword

The Applied Vehicle Technology Panel (AVT) is an international network of defence scientists and engineers dedicated to increasing the performance of new and ageing vehicles in the air, sea, land, and space domains. This network consists of about 700 experts from all fields of vehicle design, including power and propulsion, mechanical structures and material, as well as flow physics.

AVT is one of the seven panels of the Collaborative Support Office pertaining to the NATO Science and Technology Organization (STO).[1] Additionally, the STO

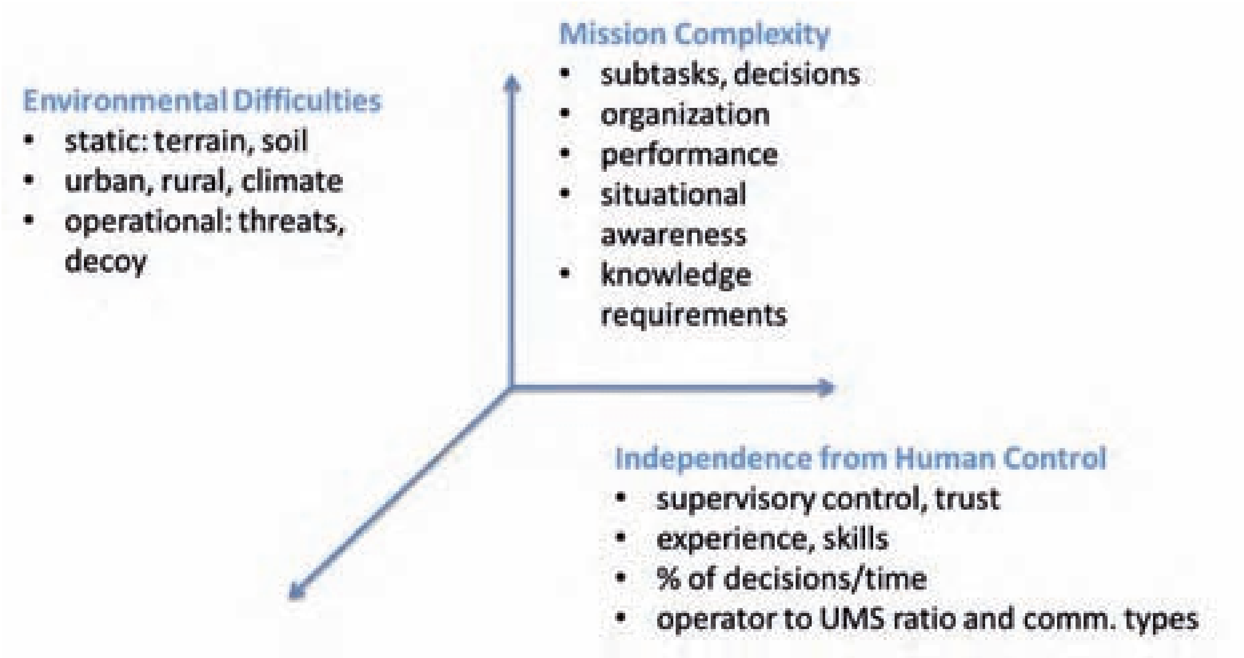


Figure 1: Contextual autonomous capability (ALFUS Model).[2]

is comprised of a dedicated research centre known as the Centre of Maritime Research and Experimentation (CMRE) as well as the Office of the Chief Scientist (OCS).

Unmanned vehicles for all domains (UxV) and aspects of vehicle autonomy are an important topic in AVT's technical portfolio. This article is based on activities performed in AVT and on contributions to a NATO Science and Technology symposium on 'Autonomous Systems' in fall 2014.[3] The article focuses on aerial and space vehicles, while many issues and statements may also apply to land or maritime systems.

UxV-Autonomy – Definition and Issues

In the last decades, military operations have changed, to a major extent, from 'traditional' warfare and homeland defence to asymmetric warfare abroad. Often, belligerents are not regular armies but groups or organizations following political, ethnic or religious goals and acting sometimes as guerrillas or terrorists. Asymmetric warfare in large and often undeveloped areas as well as in urban environments implies a big risk for loss of soldiers and uninvolved civilians, a risk that is getting less and less acceptable to 'Blue Nations' citizens. Therefore, asymmetric military operations could be supported by unmanned systems to safely enable the application of advanced technology for ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance), transportation, protection and precision strikes on enemy positions/objects. These unmanned vehicles could be used not only for dangerous but also for dull and dirty tasks. Moreover, removal of the human from the vehicle removes a vast number of issues from system design and allows for smaller, lighter and more agile craft. Autonomy from an unmanned system point of view describes the capability of a platform to accomplish a pre-defined mission with or without further human interaction and/or supervision. The degree of autonomy of the unmanned system depends on the vehicles' own abilities of sensing, analyzing, communicating, planning, decision-making, and acting (altogether forming the intelligence of the system), ranging from semi-autonomy to full-autonomy and autonomous collaboration.

The mission of a UxV and its complexity determines the required degree of autonomy of the system, and vice-versa, the technologically feasible level of autonomy may limit the operational deployment and consequently,

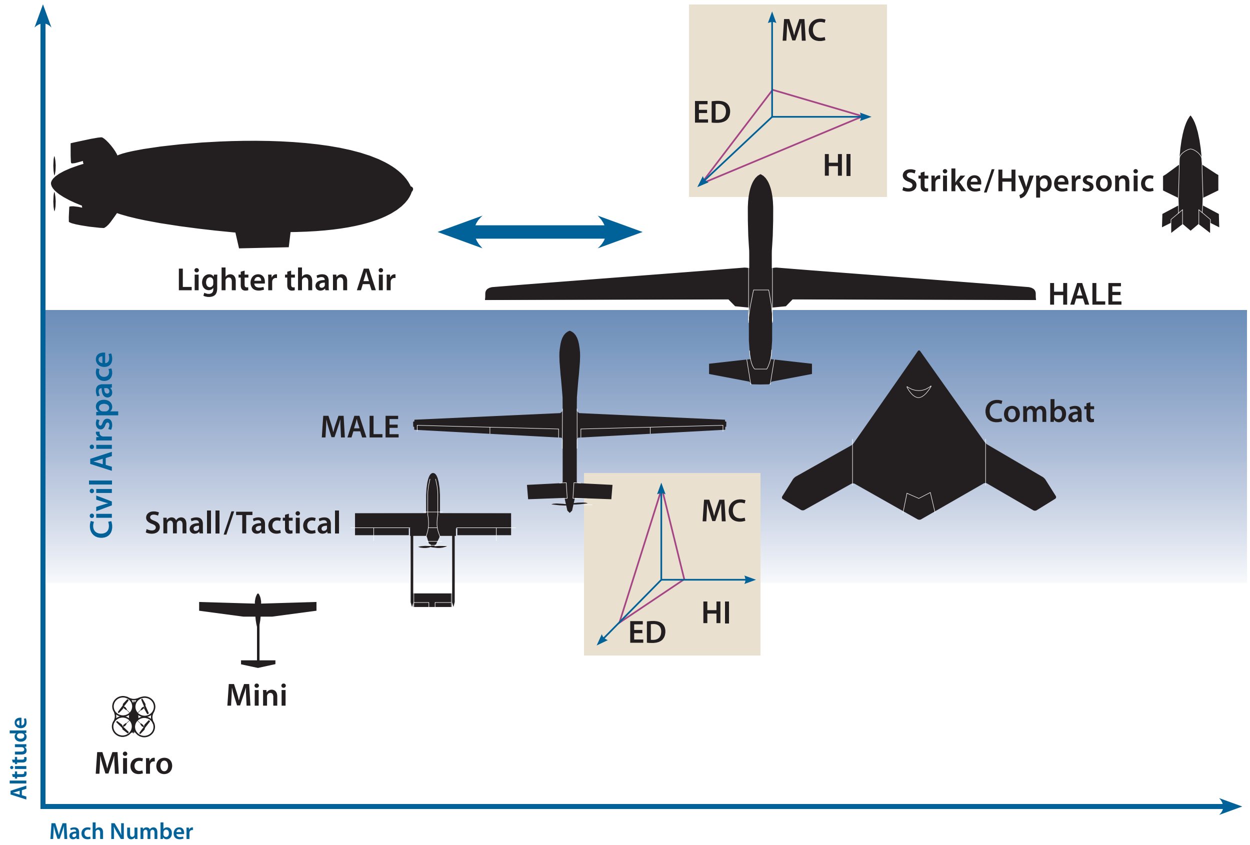


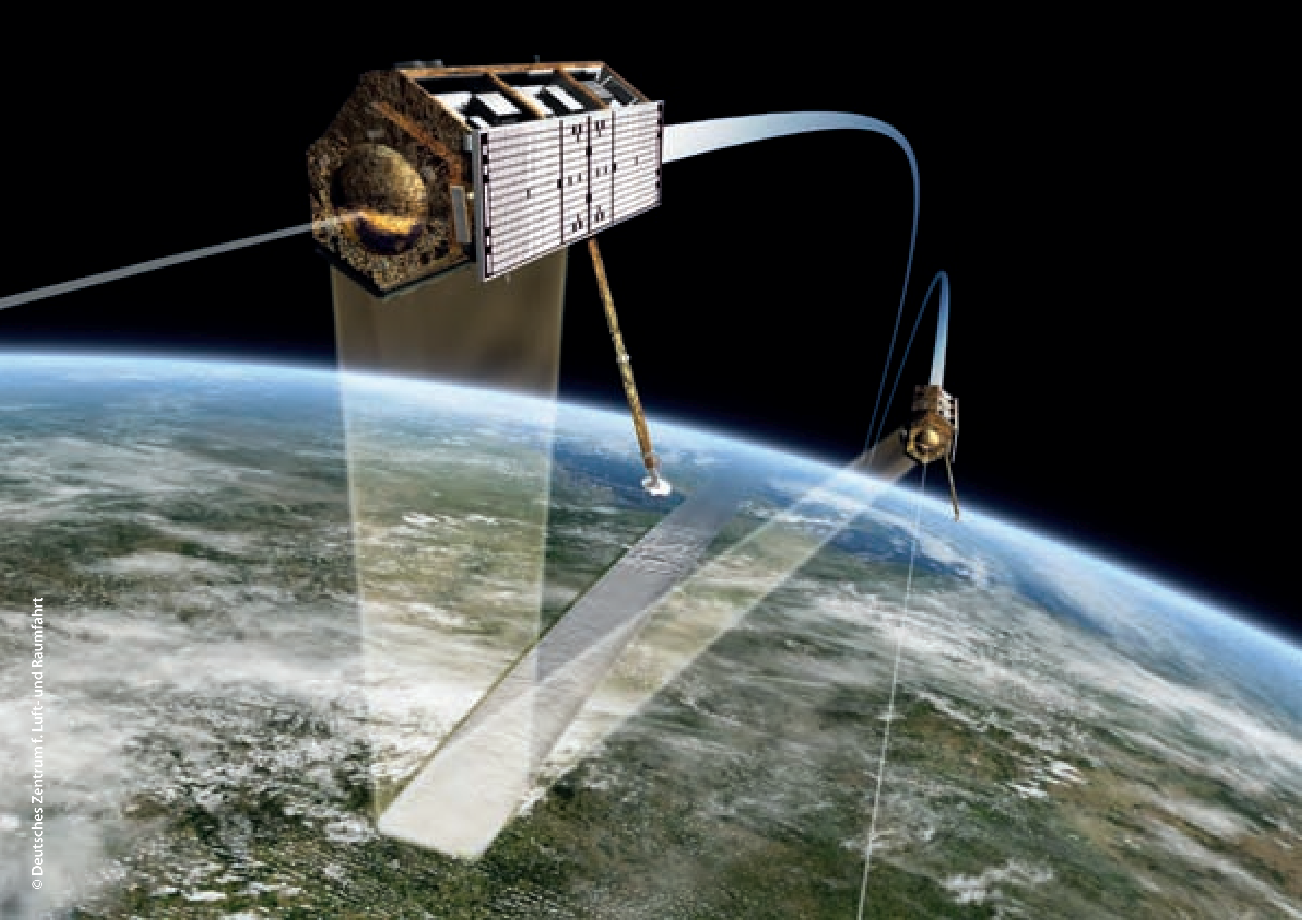
Figure 2: Categories of Unmanned Aerial Vehicles (UAV).

the mission parameters. An illustration is given by the ALFUS (Autonomy Levels for Unmanned Systems) Model as shown in Figure 1. In this three-axis model, the autonomy level is determined by the complexity of the mission that a UxV is able to perform, the degrees of difficulty of the environment within which the UxV is to perform the mission, and the level of operator interaction that is required to perform the mission. A major challenge for unmanned system autonomy is the limitation of risk during operation. For example: in the air domain, risk is inherent with operation in civil airspace, reliable and precise target identification, decision-making for lethal actions and collateral damage.

'Safety and Reliability' as well as 'Verification and Validation' are major issues regarding unmanned vehicle autonomy. Besides fulfilling the operational requirements, UxV may have to comply with international/national regulations inducing legal and liability issues. Related technical challenges also apply to civil developments such as driverless cars and aerial drones (e.g. for delivery of goods). Technical progress from the civil side will support and complement related military development.

'Autonomy from an unmanned system point of view describes the capability of a platform to accomplish a pre-defined mission with or without further human interaction and/or supervision.'

Ethical concerns exist in many countries using both UxV and autonomous UxV. These concerns are based on the false public perception that autonomy is a synonym for decision-making or lethal action by an unmanned vehicle. Quite contrary to this misconception, the US National Institute of Standards and Technology (NIST) defines a fully autonomous system as being capable of accomplishing its assigned mission, within a defined scope, without human intervention while adapting to operational and environmental conditions.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Furthermore, it defines a semi-autonomous system as being capable of performing autonomous operations with various levels of human interaction.[4] This issue cannot be solved by technical means but must be based on political and public discussion and consensus. This significant topic is beyond the scope of this article and, therefore, will not be further treated here.

UxV Autonomy (Air and Space) – State of the Art

Many modern weapons feature a kind of autonomy for the whole or a part of their mission, when they fly to a pre-determined and localized target by autopilot (e.g. cruise missiles) using inertial navigation, GPS and/or terrain mapping for guidance or when they follow and intercept a target after lock-on of the onboard seeker (e.g. air-to-air missiles). Even when those systems act fully or partly without human interaction, this feature is automation rather than autonomy. Identification/localization of the target and the decision to destroy the target are made by humans prior to the use of the weapon. Figure 2 shows categories of unmanned aerial vehicles over typical Mach numbers and altitudes of operation. Mini-UAV, small/tactical UAV, Medium and High Altitude Long Endurance UAV (MALE and HALE) are state-of-the-art and systems are operational and deployed within NATO. Micro UAV, Unmanned Combat Aerial Vehicles (UCAV) and hypersonic strike vehicles (i.e. a hypersonic cruise missile) are in a state of technology demonstration with a Technical Readiness Level (TRL)[5] typically lower than seven (TRL seven means prototype demonstration in operational environment). Operational UAVs are mainly used for ISR. To a limited extent, MALE UAVs can be equipped with missiles or bombs just like a conventional piloted military aircraft. These UAV have a high degree of automation following a course which is pre-determined or commanded/altered by an operator in the Ground Control Station (GCS), again using inertial navigation and

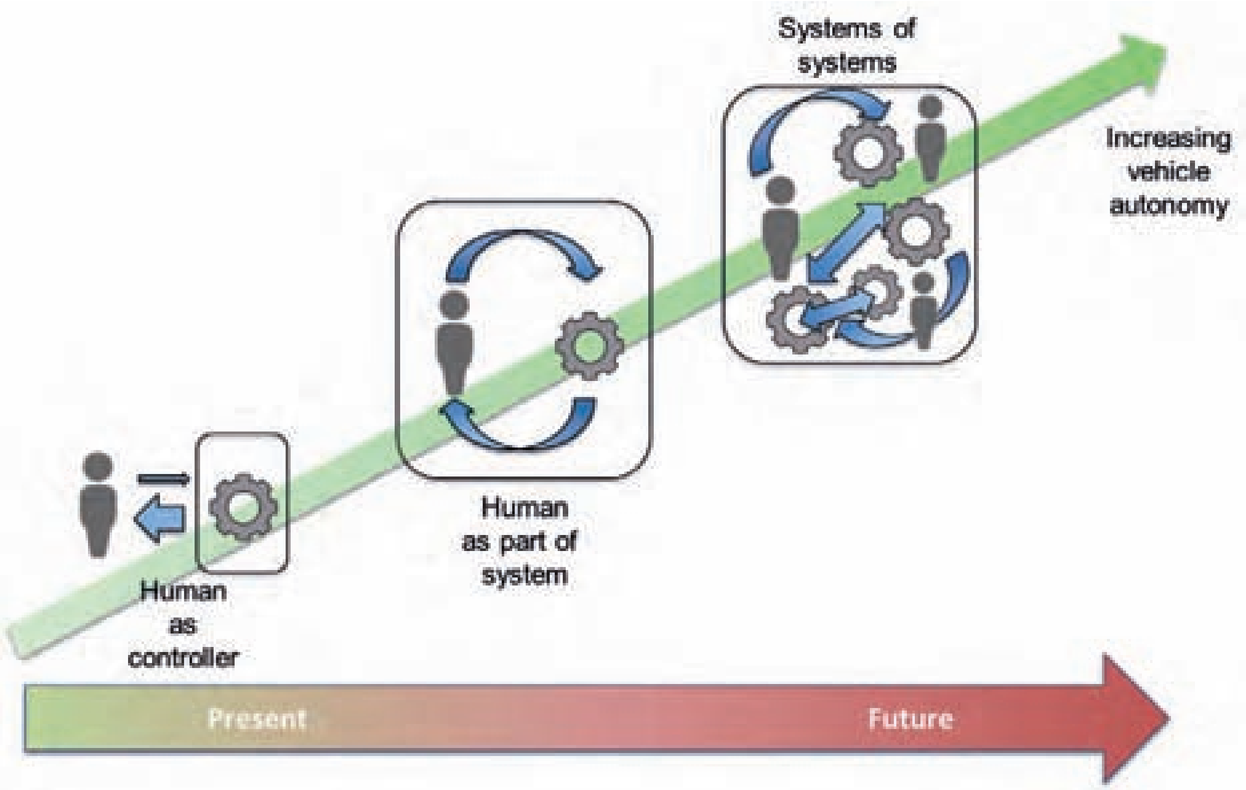

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Figure 3: Evolution of Vehicle Autonomy.

GPS. For MALE and HALE, the GCS is typically connected via a satellite link and located far outside enemy territory. Tactical UAV are typically launched by catapults or rocket boosters and return to their launch site to land remotely piloted or by parachute. MALE and HALE take off and land like a conventional aircraft and need a similar runway. They are mostly capable of automatic take-off and landing, but are typically monitored by an on-site operator. These UAV can be called semi-autonomous, when they operate on commands (e.g. course/course corrections, direction of sensors, designation of objects, destruction of targets etc.) instead of being remotely controlled, but 'intelligence' and decision-making is still the role of the human operator.

In particular, MALE and HALE systems may be required to operate in a non-segregated airspace at least for a part of their mission. This induces the need for autonomous actions to avoid mid-air collisions and to ensure an appropriate self-separation from other airspace users. This issue relates to safety and reliability, to verification and validation, as well as certification, and it may be a show stopper for acquisition, as recently experienced with the German EUROHAWK project. Figure 2 also shows two qualitative examples for autonomy in the ALFUS model.

'These concerns are based on the false public perception that autonomy is a synonym for decision-making or lethal action by an unmanned vehicle'

The MALE mission is complex in all aspects named in the model. The environment may be complex in terms of terrain (mountain regions) or climate, but especially in terms of threat, because the vehicle speed is quite slow (around Mach 0.3) and it operates at altitudes accessible to many Air Defence systems. Accordingly, the degree of autonomy is on the lower side.

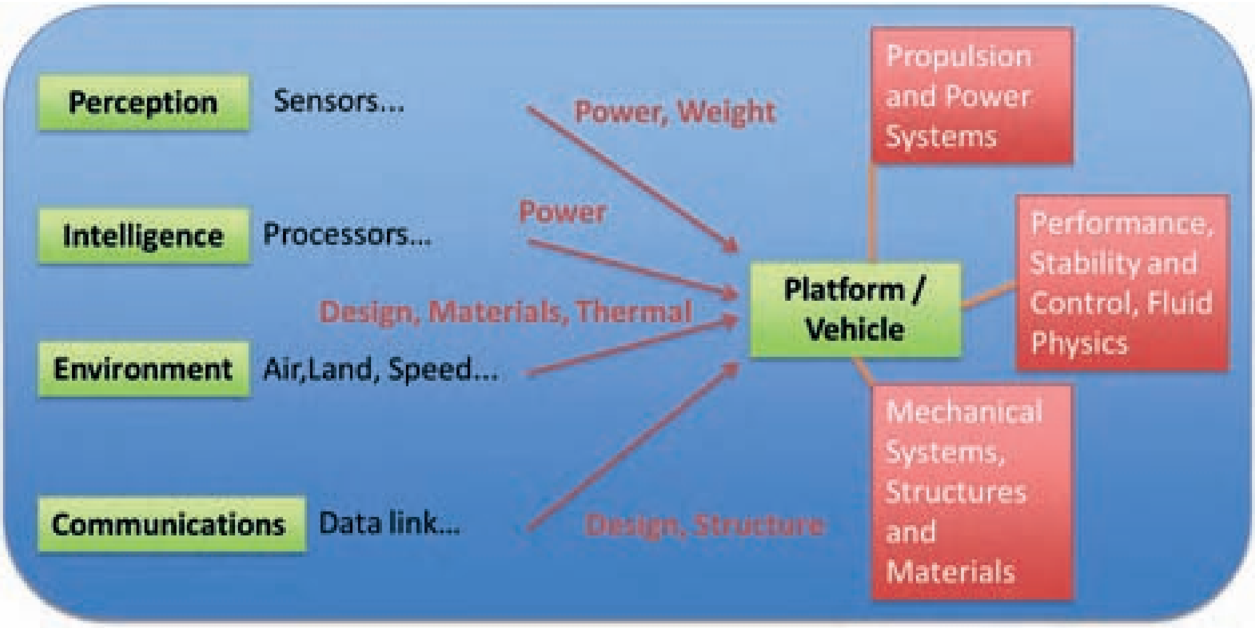


Figure 4: Key Autonomy Issues and Implications for Platform/Vehicle Aspects.

The hypersonic strike mission would be less complex and quite similar to cruise missiles today. Flight control will be more complex due to hypersonic aerodynamics and propulsion control. The hypersonic flight environment is, of course, very demanding, but threats by Air Defence should be lower. Expected autonomy will be on the higher side, covered by a smart autopilot system.

Space vehicles require some autonomous capabilities, since, depending on their orbit, they may have limited connectivity to their ground station for receiving commands. Those autonomous capabilities may include:

- Entry into a 'safe hold' mode in order to protect themselves from potential damage due to anomalous conditions;
- Routine operations such as momentum wheel desaturation, sensor pointing at pre-programmed targets, and similar activities;
- Propulsive maneuvers to stay in the desired orbit, that are pre-programmed and then executed autonomously.

Again, this is more about automation than autonomy in the sense of 'intelligence'.

UxV Autonomy (Air and Space) – The Future

In the future, more and more UxV autonomy will be required to increase effectivity and to lower the workload and endangerment of humans. Figure 3 illustrates the potential future trend:

- Today, there is a man-machine interaction, wherein the human retains the main parts of command and control. The UxV performs the commanded actions based on automated routines and sends a stream of information back, which is processed at the GCS and supports the derivation of command updates.
- The next step will be a system wherein human and machine work together as a team. They act together to achieve an objective, of course, still determined by the human part. They share information and the UxV will act more independently while the human retains direction but does less monitoring and control. Technology is gradually shifting in this direction.
- A second large step into the future would be a system-of-systems approach, wherein humans and UxV work together as a group performing a joint task. Direction will still remain with the human, but

the role will be similar to a commander of a unit. The UxV will act with a high degree of autonomy combined with highly complex communication. As an example, this could be a group of UCAV fighting together with some conventionally piloted aircraft and supported by ground, air, or space-based ISR assets. The operational future includes autonomous collaboration amongst different systems sharing required information for mutual situational awareness. This stage implies a large number of issues, which are not all of a technical nature and will not be achieved in the near future. The understanding of the potential of autonomous collaboration is still in its infancy.

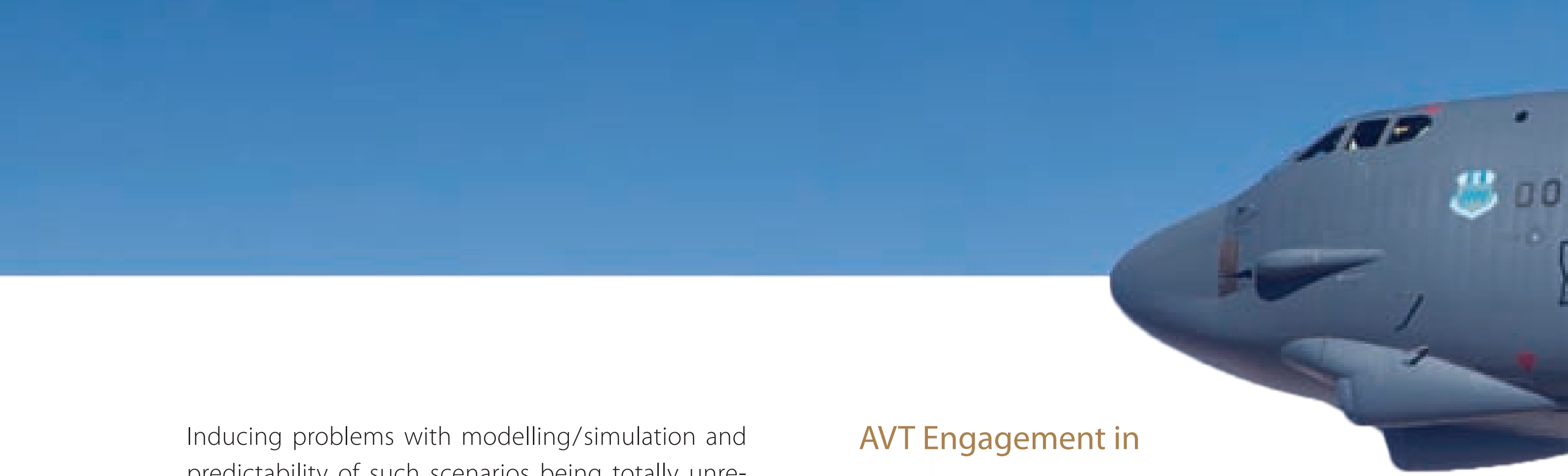
Increasing the autonomy of UxV requires an increase of on-board capabilities for

- Situational awareness;
- Fast decision-making and response to dynamic situations and environments; and
- Communication (speed, multi party, electronic countermeasures, etc.).

Technically, this means a demand for highly enhanced on-board sensing and processing capabilities and potentially for larger data link bandwidth to cope with multi party communication. Vehicle design will have to accommodate more and larger/heavier components and a significantly increased power demand. This will necessarily lead to larger and heavier vehicles, where limitations exist for space and airborne vehicles. Also, the requirements for safety, reliability and low vulnerability will likely increase for more autonomously acting and more complex and costly UxV. This will aggravate the issues with verification and validation as well as certification. A tradeoff will have to be made between benefits from increased vehicle autonomy and competing design, cost and certification implications.

Progress in the direction of human-machine teams or systems of systems raises additional issues of:

- Shared situational perception and assessment;
- Mutual understanding of behaviour (human and machine).



Inducing problems with modelling/simulation and predictability of such scenarios being totally unresolved today. Fully autonomous systems, completely independent from human directions, are unlikely to be realized in the foreseeable future.

Moving towards more autonomous UxV will require

- Investment in critical technologies;
- Development of new policies and procedures for autonomous operations;
- A paradigm shift in operational philosophy and risk acceptance.

AVT Engagement in Platform Autonomy Topics

Figure 4 illustrates how key autonomy issues impact platform/vehicle requirements and design as outline above. The technical fields 'Propulsion and Power Systems', 'Mechanical Systems, Structures and Materials' and 'Performance, Stability and Control, Fluid Physics' represent the portfolio of the three technical committees of the AVT Panel. Related technical issues of vehicle autonomy (as shown in Fig. 4) are addressed in these technical committees, while other autonomy issues may fall into the portfolio of other panels of the NATO S&T Organization1.

Stability & Control Analyses to understand the Aerodynamic Behaviour of UAVs Ranging From Micro UAVs to MALE, HALE and UCAVs (AVT-161, AVT-184, AVT-201, AVT-202, AVT-ET-143, AVT-ET-144).
Innovative Control Technologies (AVT-239).
An AVT Specialists Meeting will address the specific technological and operational issues connected to UGVs (AVT-241).
Qualification and Structural Design Guideline for Military UAVs (AVT-174); guideline is applied in different NATO and NATO nations activities.
Analysis of airworthiness and certification requirements for UAVs taking into account NATO STANAGs and the present state of regulations among NATO nations (AVT-ET-147).
Exploration of procedures for the assessment of system mission performance as a function of platform autonomy for unmanned land, sea, and air vehicles as current methodologies are insufficient (AVT-175) with the results: • Development of two new methods for performance assessment. • A new performance assessment tool that predicts platform unmanned systems performance for a given mission and environment at a given specific autonomy level. • Mission Performance Potential (MPP) tool (described in the Technical Report of AVT-175). • MPP separates autonomy level and mission performance to provide a predictive measure of a UMS's expected performance for a mission and level of autonomy. • An AVT-175 follow on activity will validate the MPP algorithms against actual data from UMS testing, competitions, and in-theater deployments.

Table 1: Recent and current AVT activities in the field of UxV.

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Recent and current AVT activities in the field of UxV are listed in Table 1.

Documentation of completed activities is available for members of NATO nations on the NATO S&T Website https://www.cso.nato.int

Conclusions

Unmanned platforms will become increasingly more important for all types of operations. Tactical UAV as well as MALE and HALE systems are operational for intelligence, surveillance and reconnaissance purposes. The larger aerial systems can be weaponized and destroy identified targets. These UxV feature a high degree of automation which enables a semi-autonomous operation, while 'intelligence' and decision-making is retained by the human operator. The same is true for space based systems. Many issues discussed in this article also apply to land or maritime unmanned systems.

When operation of automated/autonomous UxV interferes with civil airspace (or shipping traffic), major issues arise with safety and reliability, verification and validation as well as certification.

Artificial Intelligence has to be transferred to the unmanned platform to increase the autonomous capabilities. Platform survivability is a key military capability especially for complex missions where a higher degree of autonomy is required for smart decision-making to avoid potential threats. Additional equipment for sensing, data processing, communications and power generation/power storage is needed for this purpose, with the drawback of increasing the size and mass and complexity of the unmanned platform. Moreover, the stability and control characteristics of the platform need to be precisely predicted to provide the required data for autonomous operations.

'Fully autonomous systems, completely independent from human directions, are unlikely to be realized in the foreseeable future.'

Looking in the direction of humans as part of a system-of-systems approach, operational complexity as well as predictability of such scenarios and the safety and reliability issue will pose limitations unlikely to be overcome in the near future. Various aspects of unmanned platform autonomy have been covered by activities of the AVT Panel of the NATO S&T organization. Key issues are currently addressed such as UxV certification, stability & control prediction methods as well as the assessment of system mission performance as a function of platform autonomy, which will allow a trade-off between effectiveness of operation and inherent technical and commercial investment and risk.

1. The STO is governed by the NATO Science & Technology Board (STB), which is chaired by the NATO Chief Scientist. For further details, please consult the STO website at http://www.sto.nato.int.
2. Hui-Min Huang, Kerry Pavek, Brian Novak, James Albus, and Elena Messina, 'A Framework For Autonomy Levels For Unmanned Systems (ALFUS)', Proceedings of the AUVSI's Unmanned Systems North America 2005, Jun. 2005, Baltimore, Maryland.
3. NATO S&T Symposium, STB-ES 'Autonomous Systems', Bratislava (SLK), 19 Sep., 2014.
4. National Institute of Standards and Technology, US Department of Commerce (http://www.nist.gov/el/isd/ks/upload/NISTSP_1011-I-2-0.pdf).
5. Cf. Technology Readiness Assessment (TRA) Guidance, United States Department of Defense, Apr. 2011.

Dipl.-Ing. Hans-Ludwig Besser

was Technical Director of Bayern-Chemie GmbH, a subsidiary of MBDA Missile Systems for 18 years. He is still working as senior consultant to the company. Hans L. Besser has worked in different divisions of predecessor companies of EADS (today Airbus) and has more than 35 years of experience in the development of tactical missile propulsion and inherent missile system issues. He was engaged in various technology demonstrators (hypervelocity) and missile systems like ALARM, VT1, and especially the development of the ramjet propulsion for the European Air Dominance Missile Meteor. Hans L. Besser has a Dipl. Ing. degree for technical physics from the Technical University Munich (Germany).Hans L. Besser is Panel Member of AVT since 1998 and chairs the Strategic Committee of the Panel since 2011. He received two Panel Excellence Awards for his service.

Dr.-Ing. Dennis Göge

started his career at the German Aerospace Center (DLR) in 2000 as Research Scientist. In 2005 he became Deputy Department Head and Head of a Research Group at DLR in Göttingen, Germany. After having worked from 2005 to 2007 in this position he then joined the Science and Technology Organization (STO) of NATO in Neuilly-sur-Seine, France, as Executive Officer. In 2010, Dr. Göge has been appointed Executive Board Representative and Program Coordinator Defence and Security Research at DLR in Cologne, Germany. Actually, Dr. Göge is representing DLR in various national and international supervisory bodies, advisory councils and committees. He is Member of the Science and Technology Board (STB) and Chairman of the AVT Panel of NATO's Science and Technology Organization (STO). In addition, he is an advisor to the Federal Ministry of Defence and to the Federal Ministry for Economic Affairs and Energy, Germany.

Mr Michael Huggins

started his career with Rockwell International as a Propulsion engineer in 1985 for the B-1 Bomber flight test program. In 1987, he joined the United States Air Force Rocket Propulsion Laboratory as a liquid rocket engineer. From 1993–94, Mr Huggins served as the Deputy Director of the Phillips Laboratory Propulsion Engineering Division overseeing a 110-person organization executing $80M for space access, missile defense propulsion and the beginning of the technology research for USAF ICBM strategic sustainment initiative. From 1997–99, Mr Huggins directed Space Technology planning for the Air Force Research laboratory; spearheading the development of technology roadmaps for AF micro and nano-satellites. From 2000–present, Mr Huggins has directed planning and execution for $120M annually in exploratory research and development programs in S&T areas related to advanced missile, rocket, and spacecraft propulsion. He is the Vice Chairman and past Chairman of the AVT Panel of NATO's Science and Technology Organization (STO).

Dipl.-Ing. Dirk Zimper

joined the German Air Force in 2004 and graduated from the German Air Force Officer School in 2005. He holds an advanced academic degree in Aerospace Engineering from the German Armed Forces University Munich. Following the completion of his professional training as an Ammunition Specialist, Dipl.-Ing. Zimper worked as Head of Unit being responsible for the maintenance of air-to-air and air-to-ground missile systems as well as all pyrotechnic ammunitions for German aircrafts. Additionally he managed the process implementation of SAP in a German ammunition depot. Dipl.-Ing. Zimper was honored with the honor cross of the German Armed Forces for his service. Besides his officers' service he worked as Research Scientist in defence-related projects of the German Aerospace Center (DLR). Dipl.-Ing. Zimper currently works as Executive Officer at the NATO Science and Technology Organization (STO) being in charge of the Applied Vehicle Technology Panel (AVT).

The Multinational Aviation Training Centre (MATC)

Sharing Expert Capabilities and Experience

By Colonel Bernie 'Jeep' Willi, USA AF, JAPCC

Introduction

One of the results of conducting years of combat operations in Afghanistan is improved interoperability across the NATO nations. Despite this, it has been noted in numerous JAPCC studies that there is still a lot of room for improvement, especially in the air operations communities.[1]

One of the areas where improved interoperability is needed is in the rotary wing community. It has been documented that standardization of rotary wing qualifications across the Alliance has been an ongoing issue. A potential solution for this standardization issue would be to establish a training facility where NATO rotary and fixed wing aircrew and maintainers can receive education and training that addresses this issue. Fortunately, such a solution is evolving with the foundation of the Multinational Aviation Training Centre (MATC).

The Roots of the MATC

The roots of the MATC can be traced to the Multinational Helicopter Initiative (MHI) and the subsequent Air Advisor Team Pre-Deployment Training (AAT-PDT) course programme.

The MHI was established in 2008 on the basis of a bilateral summit between France and the UK and is designed to support the development of a number of

multinational transport helicopter projects. Initially focused on raising the number of mission capable helicopters for ISAF, it seeks to help those countries that do not have the resources to deploy and run a transport helicopter operation on their own. In addition, the MHI supported the European Defence Agency (EDA) led Helicopter Exercise Programme (HEP) – including HOT BLADE exercises – and training packages under the common title of Helicopter Training Programme that include several courses such as the Helicopter Tactics Course, Helicopter Tactics Instructor Course and Operational English Language Course. The MHI also supported the HIP Helicopter Task Force (HTF) initiative which facilitated deployment of Czech helicopters to ISAF in 2010–2011. The HIP HTF initiative includes 10 nations (Albania, Czech Republic, Hungary, Italy, Norway, Poland, Slovakia, Spain, UK and USA). Being created in February 2009, it is currently moving towards termination as most of its objectives were taken over by MATC.

The first AAT-PDT course started in 2012 as an effort to streamline the preparation and training system for aviation personnel (helicopter aircrew and maintenance specialists) for the nations supporting the Aviation Security Force Assistance (AvSFA) advisory teams across Afghanistan. The main objectives of this course were to standardize aircrew procedures, consolidate the conduct of mentor training, and improve the overall level of flight safety for the participating nations. The AAT-PDT consists of two parts – simulator training at the Helicopter Training Point (HTP) Ostrava, Czech Republic and flight training at Zadar Air Base, Croatia. Each course is supervised by experienced contracted helicopter instructors and typically supports approximately forty personnel from Czech Republic, Croatia and Hungery. For each course, 20 aircrew members attend the Simulator Phase and twenty maintenance personnel join them for the flying training in Zadar.

A Smart Defence Initiative

Capitalizing on this success, the Czech Republic conceived the initiative to build the MATC. Building on operational experience gained in Afghanistan and elsewhere, the MATC project seeks to provide and share expert capabilities and experience for the benefit of NATO, EU and partner nations under the 'Smart Defence' initiative. It would enable the participants to:

- Improve, harmonize and standardize training and education;
- Improve interoperability and helicopter capabilities;
- Take an active role in development of training standards and concepts;
- Provide conditions to deploy helicopter capabilities and trainers to theatres of operation via a comprehensive and standardized training scheme.

'One of the areas where improved interoperability is needed is in the rotary wing community.'

So far, NATO has registered 26 projects as 'Tier 1' Smart Defence projects, one of which is the MATC. These Smart Defence projects seek to improve operational effectiveness, employ economies of scale, and improve connectivity between national forces. 'Smart Defence' is a new way of thinking about generating the modern defence capabilities that the Alliance will need for the coming decade and beyond, particularly through multinational cooperation that allows countries to develop and sustain capabilities that they otherwise cannot afford. It centres on a renewed culture of cooperation that encourages Allies to cooperate in developing, acquiring and maintaining military capabilities to undertake the Alliance's essential core tasks agreed in the new NATO strategic concept. That means pooling and sharing capabilities, setting priorities and coordinating efforts better.[2]

Road to Full Operational Capability

A Letter of Intent (LOI) to work together towards establishing the MATC was signed by Croatia, Czech Republic, Slovakia and USA on 21 February 2013. Hungary also formally joined this initiative on 20 September 2013. The Initial Operational Capability (IOC) of the MATC is planned for 2015 and Full Operational Capability (FOC) should be achieved about two years later.

The MATC Focus Areas

Initially, the MATC will provide comprehensive training for flying and maintenance personnel from allied and partner nations on MI-type helicopters in order to maximize the use of existing capabilities and structures while minimizing overall costs. It will focus on the deployment of helicopter detachments in support of NATO operations as well as preparing Air Advisor Teams, which will provide training to Afghan National Security Forces (ANSF) as long as that requirement continues to exist.[3] The focus will include multinational logistics, operational doctrine development, education, mutual recognition of airworthiness rules, and other possible areas. The MATC further seeks to increase interoperability of rotary wing aviation in support of AvSFA requirements, assist in the development of AvSFA doctrine and training, and capitalize on the 'Smart Defence' initiative to reduce redundancies, increase efficiency and reduce national financial and personnel expenditures. It will do this by standardizing education and training, improving technical and tactical standards as well as improving the common deployment capability of helicopter crews and of ground maintenance experts.[4]

MATC Support to Special Operations

The work the MATC currently accomplishes to support AvSFA teams addresses another acknowledged NATO issue. At the NATO Summit in Riga, Latvia in 2006, NATO identified that it had a significant shortfall in its total Special Operations Forces (SOF) capacity and capability. It chartered the NATO SOF Transformation Initiative to address this issue.[5] This initiative focused on three areas that include enhancement of SOF staff capacity at Supreme Headquarters Allied Powers Europe (SHAPE), establishment of a NATO SOF coordination centre and development of a NATO federation of NATO SOF training centres.[6] This federation of SOF training centres would enable a rapid leap forward in SOF interoperability and training through linking national/multinational facilities. They would:

- Capitalize on an inherent strength of the Alliance to better enhance the cohesion and interoperability;
- Reduce the duplicative infrastructure;
- Capitalize on subject matter expertise;
- Expand the capabilities of nations with nascent SOF;
- Bring together unique SOF training opportunities and facilities NATO-wide.[7]

Through improving overall NATO AvSFA capabilities, the MATC can significantly contribute to 'military assistance', one of the three core tasks of NATO SOF (besides strategic reconnaissance and direct action), and thereby help to ease the identified SOF capability shortfall. The MATC could be one of the SOF training centres mentioned in the SOF initiative and could eventually support other types of helicopters or fixed wing aircraft with an adequate level of NATO support. It is currently considering the possibility of supporting other helicopters or fixed wing aircraft in the future if it is determined the requirement exists.

Outlook

Despite the sweeping changes that are going on in Afghanistan with respect to NATO's future involvement, a statement in the NATO Chicago Summit declaration from 2012 indicated that a post-2014 mission of a different nature, to train, advise and assist the ANSF, including the Afghan Special Operations Forces, will continue in Afghanistan.[8] This SFA competency to train, advise and assist partner nations will improve NATO's ability to advance NATO interests and security. A robust SFA capability permits NATO to 'engage actively to enhance international security, through partnership with relevant countries and other international organizations,' 'employ an appropriate mix of […] political and military tools to help manage developing crises that have the potential to affect Alliance security, before they escalate into conflicts' and 'help consolidate stability in post-conflict situations where that contributes to Euro-Atlantic security.'[9] The ability to provide air-centric training, advice and assistance to a partner nation's aviation organization(s) has been recognized as an important tool in the mentoring and development of relations with non-NATO partner nations where common interests are shared with NATO, especially as NATO's role in the world evolves post-Afghanistan. AvSFA can improve internal and regional security and stability as well as create an environment for improved economic development. The MATC can be an important tool in helping to improve NATO's SFA and AvSFA capability as one of the SOF Training Centres. As another option, it could also serve as the foundation for a NATO SFA Centre of Excellence. In either one of these forms, MATC could address many long standing NATO shortfalls. From standardization issues to SOF capacity gaps to aircrew qualification matters, the MATC could form the bedrock for addressing NATO SOF concerns that could help evolve the Alliance so it is better suited for the defence challenges of the future. ●

1. JAPCC studies like 'Improving NATO Support to Future Air Advisor Operations' and 'Enhancing NATO's Operational Helicopter Capabilities – The Need for International Standardisation' highlight interoperability issues and the air operations community.
2. Smart Defence, http://www.nato.int/cps/en/natolive/78125.htm.
3. Mediabackgrounder;Jun.2014,http://www.nato.int/nato_static/assets/pdf/pdf_2014_06/20140602_140602-Media-Backgrounder_Multinational-Projects_en.pdf.
4. MATC Multinational Project Team, MATC Concept, (28 Feb. 2013).
5. SOF Initiative Slides.
6. Ibid. 5.
7. Ibid. 5.
8. Chicago Summit Declaration; Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Chicago on 20 May 2012.
9. 2010 NATO Strategic Concept, Para 4.

Colonel Bernie 'Jeep' Willi

was a distinguished graduate of the USAF Academy in 1990 and an honor graduate of US Army Flight Training at Ft Rucker, AL in 1991. Colonel Willi holds a Master's Degree from Embry-Riddle Aeronautical University and is a graduate of the USAF Squadron Officer School, US Naval Weapons School, USAF Air Command and Staff College, and the USAF Air War College. He was the Personnel Recovery Core Function Team Chief at HQ Air Combat Command, Langley AFB, VA, served as the Commander of the HH-60 Combined Test Force, Nellis AFB, NV and was the Deputy Group Commander of the 438 Air Expeditionary Advisory Group. Colonel Willi was an HH-60G/H, SH-60F and Mi-17 evaluator pilot and has flown combat missions in Operation Southern Watch and Operation Enduring Freedom. Colonel Willi is currently the Combat Air Branch Head at the Joint Air Power Competence Centre in Kalkar, Germany.


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2015: The First Six Months

By the Editor, Air Commodore Madelein M.C. Spit, RNLAF, Assistant Director, JAPCC

The JAPCC team has had a busy six months, supporting meetings, processes, and activities from across the range of Joint Air Power. While there is far too much to include everything, here are a few highlights from the first half of 2015:

- Exercises and Lessons Learned: JAPCC personnel participated in exercise preparation activities for Exercises Ramstein Ambition II (to execute in June 2015), and Trident Juncture 15 (to execute in October 2015), as well as participating in the Execution Phase of Exercise Trident Jewel 15 in March.
- Concepts and Doctrine: The JAPCC, working closely with the NATO Standardization Organization (NSO), has moved several NATO publications into the review or ratification phases, among them AJP 3.3(b) (ALLIED JOINT DOCTRINE FOR AIR AND SPACE OPERATIONS). AJP 3.3 also includes a newly revised Chapter 5, which focuses on Space Operations, which was developed under the leadership of the JAPCC Space team. Significant work was completed in moving ATP 49 (USE OF HELICOPTERS IN LAND OPERATIONS) towards the ratification phase.
- Capability Development: JAPCC members are deeply involved in NATO efforts to determine the successor to the NATO Airborne Early Warning & Control capability and are working closely with the NATO Air Traffic Management Committee to ensure the rollout of the Single European Skies Project for the civilian aviation is matched with needed capability and procedural upgrades for military aviation.
- Education and Training: A significant milestone in NATO Force Protection training was accomplished when the first mobile education and training team travelled to Poland to provide the Polish AF a train-the-trainer course in support of their national FP requirements. The JAPCC Air Transport (AT) team is well into a study focusing on AT training in NATO, cooperating in this effort with the EATC and the EDA.

These are just a few highlights of JAPCC activities that have occurred so far this year. JAPCC members are leading and participating in efforts to continuously transform NATO to meet the ever-changing security environment.

Cooperation between the JAPCC and the University of Lincoln

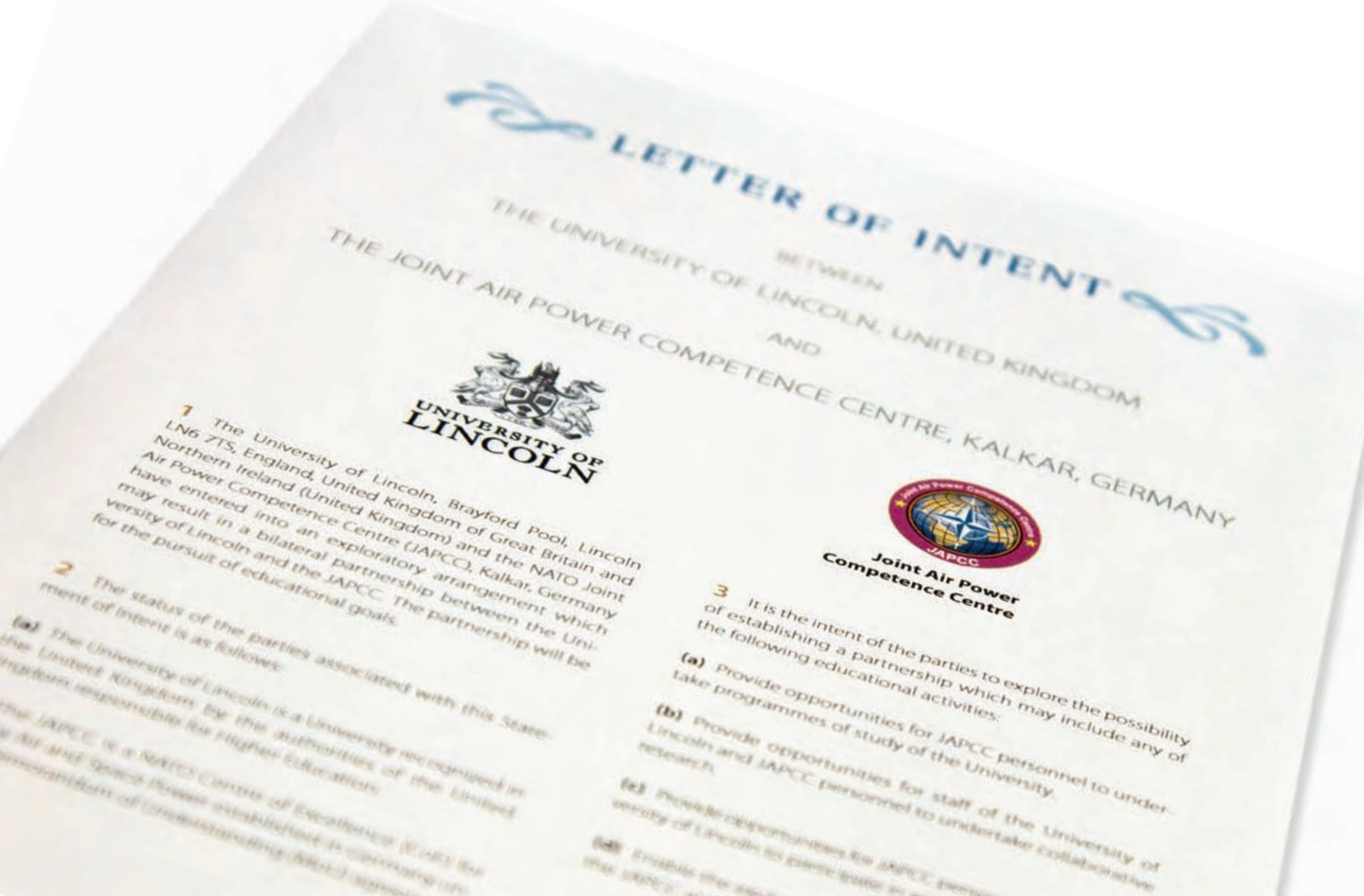
During the JAPCC conference in November, 2014, a Letter of Intent was signed by the Executive Director, Lieutenant General Wundrak, and Dr David Cobham, head of the School of Computer Science at the University of Lincoln, United Kingdom.

At the previous JAPCC Conference in 2013, one of the dominant themes was Education and Training, including the subject of 'Intellectual Interoperability'. One of the guest speakers was Mr Kevin Jacques from the University of Lincoln, an institution with very close ties to the UK military and the Royal Air Force in particular.

Mr Jacques highlighted the university's deep understanding and experience regarding the education and training of military personnel. As a result, the University was requested to conduct a 'trial' course titled 'Enhancing Research Skills' for four of JAPCC's Subject Matter Expert's (SMEs). The trial was deemed such a success that a more formal arrangement now exists between the two organizations.

A signing ceremony marked the beginning of a close relationship allowing for the professional development of JAPCC personnel at the University of Lincoln campus. The curriculum being offered encourages JAPCC SMEs to 'immerse' themselves in the English language throughout the course of study. Students receive a total of 40 hours of dedicated on-site direct support which includes instruction on academic research, writing, and grammar. The same tutor supports each student using Distance Learning methods for a period of eight additional weeks, while the SME authors a 4,000 word essay on a pre-determined Air & Space Power topic.

The University of Lincoln and the JAPCC are planning to conduct two to three Enhancing Research Skills courses per year.



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2014 JAPCC Conference

The 2014 Joint Air Power Competence Centre Conference was held between 18th and 20th November in Kleve, Germany. Attendees from across the NATO Joint Air Power community gathered to explore the ideas and conclusions from the JAPCC Future Vector Project (FVP), and debated where NATO air and space power should aim to develop to meet the challenges unfolding in the wake of operations in Afghanistan, and the changing security environment that had developed during 2014.

The evening of the 18th, an ice-breaker reception was held, at which Lieutenant General Wundrak, the Executive Director of the JAPCC, welcomed the delegates. Additionally, several members of industry shared their thoughts on the issues to be raised at the conference. The next morning, the conference began with a provocative and interesting Key Note address delivered by the Ambassador Stephan Evans, who spoke on the wider strategic context effecting the Joint Air Power conversation. Following this introduction, several panels, made up of FVP authors and recognized Joint Air Power experts, presented, answered questions, and participated in discussions regarding the FVP essays.

The evening of the 19th, the Conference delegates attended the annual Gala Banquet, at which the Director of the JAPCC, General Frank Gorenc, spoke on the history of Joint Air Power in NATO, providing further context to the conference focus. The final day of the conference was dedicated to two more sessions focusing on FVP topics and a final 'Activiation' session, at which the delegates en masse discussed the way forward with regards to Joint Air Power in NATO. Among other thoughts, one clear consensus emerged: the conversation was only begun at the Conference and needed to be taken further in order to assure that Joint Air Power is available as a tool for NATO's political leaders.

For a more in-depth discussion of the 2014 JAPCC Conference, please visit the JAPCC website at www.japcc.org and download the Conference Proceedings, which provide analysis of the topics discussed at the conference.

Mitigating Disinformation Campaigns Against Air Power Project

On 1 September 2014, the JAPCC started the 'Mitigating Disinformation Campaigns against Air Power' Project. The Project will examine one of the most serious threats against NATO airpower that we now face: disinformation campaigns carried out against NATO and Coalition forces that routinely characterize airpower as an inhumane and indiscriminate weapon of war that deliberately targets civilians and civilian institutions. The aim of the Project is in line with NATO's work to identify problems and solutions to ensure that airpower continues to be a key enabler of NATO Security. It will provide doctrinal, policy and training recommendations to meet the threat of disinformation and to improve NATO's Strategic Communications (StratCom) in future air operations. Finally, the Project will form the basis of a flexible course of training to be developed for NATO personnel to deal with the challenge of disinformation aimed against NATO airpower.

The study will scrutinize the role of airpower and disinformation in recent air campaigns and develop several case studies of the European nations that have employed airpower in recent conflicts to examine the NATO and national forces reaction to negative reports on air strikes. The initial case studies will focus on Germany, France, UK, Italy, and the USA. To conduct this research, the JAPCC has created a team of six experienced and highly qualified academics with solid research and publication records in the field of security studies for the project.

The topic of this project will be discussed during the upcoming JAPCC Annual Conference 2015 'Air Power and Strategic Communications – NATO Challenges for the Future', 23–25 November 2015, Essen, Germany.

The JAPCC Annual Conference 2015 White Book will be published by September 2015. ●

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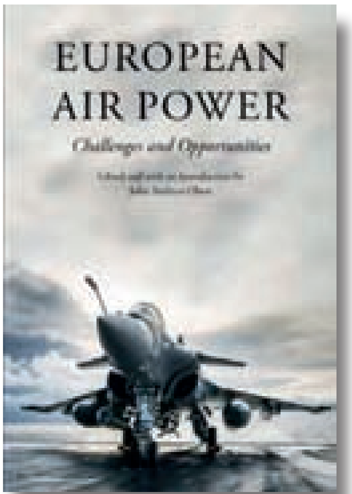
‘European Air Power – Challenges and Opportunities’



Potomac Books/
University of Nebraska Press 2014
Reviewed by:
CMS Gaetano Pasqua, Ph.D. ITA AF, JAPCC

European Air Power-Challenges and Opportunities, edited by Colonel Professor John Olsen, provides a good analysis and understanding on the current Air Power situation in Europe.

There are eight contributions from Air Chiefs and independent experts examining the current status of eight air forces in Europe, including Norway, Denmark, Sweden, Finland, France, Germany, Turkey, and Great Britain. Each contribution takes into account the geopolitical, operational infrastructures and national military organizations. It is evident that, if nations want to compete in the current geopolitical international arena, there is a cost impact to do so. There is a real need to deal with the financial restraints imposed by national governments and dictated by economic scenarios.

According to the authors, it is clear that Air Power will continue to play a vital and important role in coming decades. This book is a great work and is aimed at professionals, academics, or simply individuals who wish to approach the fundamentals of European Air Power from a layman perspective. A must read for politicians who deal in defence matters!

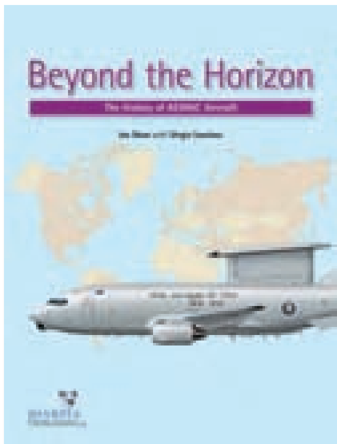
‘Beyond the Horizon – The History of AEW&C Aircraft’

A search of the extensive library on Air Power reveals something of a void – where are the books on Airborne Early Warning and Control, past present and future? ‘Beyond the Horizon’ seeks to address this gap.

The book provides a comprehensive, tech-lite, narrative-rich, history of AEW&C from its rudimentary beginnings in the 1940s to the present day. It accurately maps the non-linear evolution of the capability, a pace of which has been driven by both strategic imperative and technological advancement. The narrative is cleverly lightened and lifted by use of personal accounts to illuminate the history.

The final section looks at current capability, by nation and aircraft type, and provides a tempting glimpse of the future. The sophistication and specification of modern AEW&C platforms means much of this information is classified and cannot be included. Nevertheless, this section remains a rich source of reference.

The fact that it took nine years to write the book illustrates the dearth of readily accessible material on the subject, but it is also a strong indication of the depth and breadth of the author’s research. This is a book which will have wide appeal to anyone with an interest in Air Power. For military airmen it provides an essential knowledge of the capability. For those within the AEW&C community it is a reaffirmation of what we all know – AEW&C is not an enabling function but a core Air Power capability in its own right.



By Ian Shaw with Sergio Santana
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