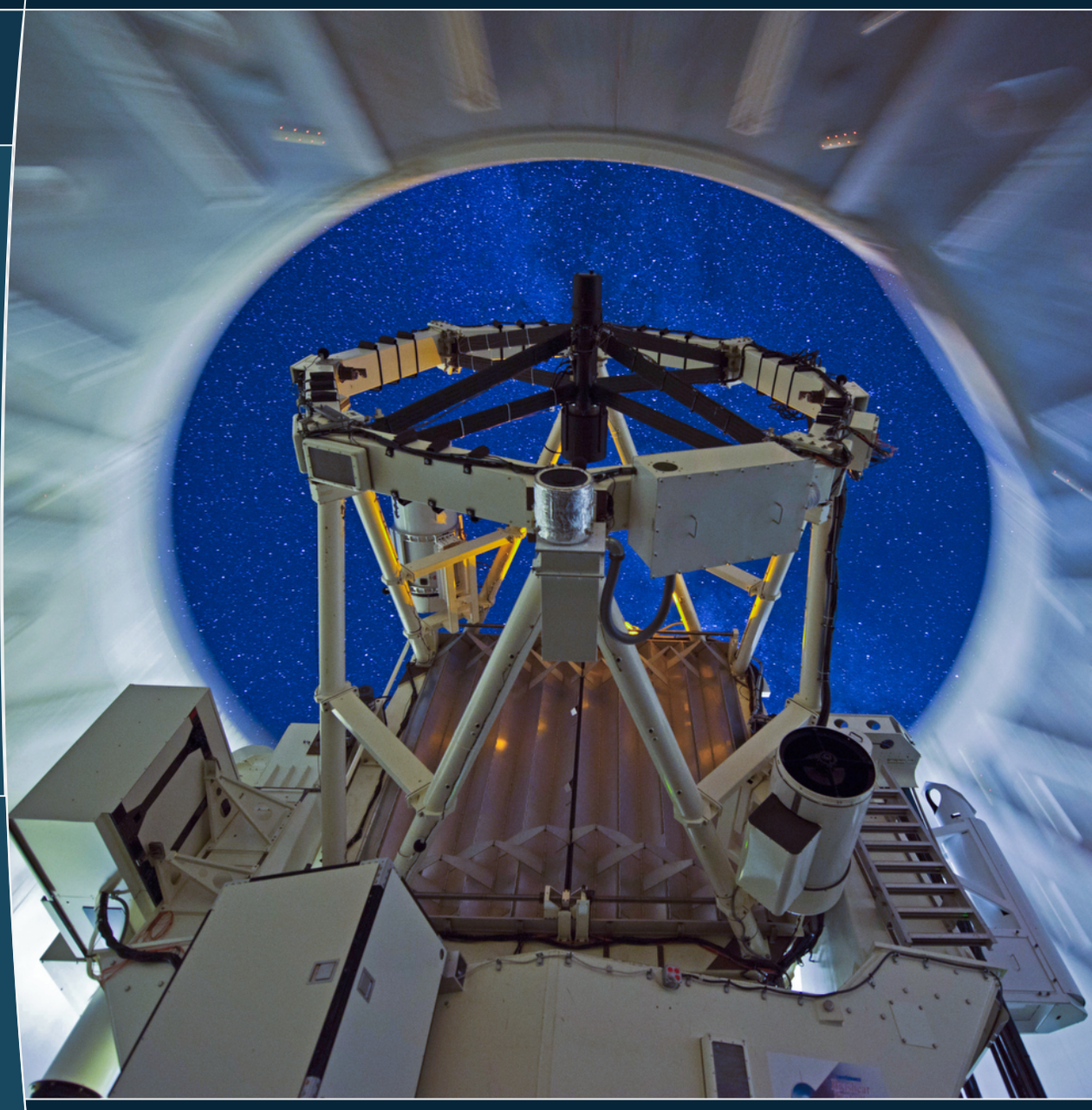
NATO SPACE OPERATIONS:

The Case for a New NATO Center of Excellence.

By Colonel Paul A. Tombarge



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Cover Photo Credit: A light anomaly above the Maui Space Surveillance Complex. The Maui Space Surveillance Site (MSSS), located on top of Mt. Haleakala, HI includes three facilities for identifying man-made objects in orbit. The three systems includes the Air Force Maui Optical System (AMOS), The Maui Optical Tracking and Identification Facility (MOTIF), and a contiguous Ground-based Electro-Optical Deepspace Surveillance System (GEODSS) facility. (U.S. Air Force photo/Tech. Sgt. Bennie J. Davis III)

Introduction

There is no doubt current North Atlantic Treaty Organization (NATO) operations depend extensively upon space capabilities and, given NATO trends towards ballistic missile defense, precision, reach-back, communication, and maximum flexibility, the use of space is only likely to increase in the future. In 2012, NATO's Joint Air Power Competence Center (JAPCC) put forth a broad framework for a NATO space policy. JAPCC originally developed the proposal and provided it to Allied Command Transformation (ACT) Space Integrated Project Team, known colloquially as the Space IPT.[1] While the Space IPT subsequently decided to suspend its efforts on the policy front, development of a NATO space policy is still worthy of continued investigation.

Whether or not an overarching NATO space policy is developed, an operational framework must be established that enables the Supreme Allied Commander Europe (SACEUR) and his subordinate commanders to exploit and synchronize available Alliance space assets. This framework must include a common space operations doctrine, a well defined space command and control structure, and trained space operations professionals in the right positions at the right organizations.

Once the operational framework is defined, an accompanying education and professional development framework of such a Center of Excellence (COE) must be established. One potential solution is the establishment of a NATO Space Operations COE. NATO currently has 18 accredited COEs, with three others in development. "These COEs…offer recognized expertise and experience that is of benefit to the Alliance and support the transformation of NATO, while avoiding the duplication of assets, resources and capabilities already present within the NATO command structure."[2]

This paper will seek to define both the operational and professional development framework and set forth proposals on how to bring them to reality. Specifically, it will provide a historical overview of military space operations, discuss the importance of space capabilities to NATO, present thoughts on space warfighting doctrine, provide an overview of NATO space capabilities, offer recommendations for command and control of NATO space forces, propose methods of developing and integrating space expertise across NATO, and supply ideas on how to exercise the concepts put forth.

Historical Overview of Military Space Operations

Before discussing why space capabilities are important to NATO or how operational and professional development frameworks could be developed, it is important to understand the history of military space operations.

With the Soviet Union's unexpected launch of the world's first man-made satellite (Sputnik I) in 1957, space was recognized as the ultimate high ground. From space, nations could watch, plan, warn, and react, even before a crisis developed. In the event of nuclear war, ICBMs would travel through the medium of space to strike their targets. With this realization, the U.S. military began research and development of a wide variety of space capabilities, including space

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[1] "Filling the Vacuum: A Framework for a NATO Space Policy," http://www.japcc.org/publications/report/Report/Filling_the_Vacuum-A_Framework_for_a_NATO_Space_Policy.pdf, accessed 5 December 2014.

[2] NATO Centres of Excellence, http://www.nato.int/cps/en/natolive/topics_68372.htm, accessed 23 October 2013.

launch vehicles; communications, meteorology, geodesy, navigation, missile warning and reconnaissance satellites; ground-based missile warning and space surveillance sensors; and satellite control networks.

The U.S. Air Force was the lead service for the majority of U.S. space systems and within the U.S. Air Force, most of these capabilities were assigned to the Strategic Air Command (SAC). Their primary purpose within SAC was to aid nuclear deterrence and execution of nuclear war plans. "The alert status of B-52 bombers, for example, was based on the warning time afforded by [Defense Support Program] satellites. Targets and yields depended on information gained by overhead imagery."[3] Space capabilities were key to determining nuclear strategy, force structure, and operational concepts. "Hence, during the Cold War, there was little distance between…nuclear deterrence forces and space operations."[4]

Amidst these developmental efforts, two organizations were established: North American Aerospace Defense Command (NORAD) in 1958 to warn and defend against an attack on North America and the Joint Strategic Target Planning Staff (JSTPS) in 1960 to consolidate planning and targeting of all offensive nuclear forces in the form of the Single Integrated Operations Plan (SIOP). NORAD would warn of an incoming enemy attack, the SAC commander would order the launch of the bomber force to prevent its destruction on the ground, and if approved by the President, would execute the nuclear SIOP developed by the JSTPS.[5] Although planning and targeting for U.S. nuclear forces were now integrated, it would be nearly a quarter century before planning and tasking of joint space operations capabilities were consolidated.

While the space race began between the Soviet Union and the United States in 1957-1958, the importance of space capabilities was quickly realized around the world. In the 1960s, "satellite communications moved from pioneering experiments to commercial reality"[6] as dozens of commercial companies and international consortiums developed and launched communications satellites. This included, in 1964, "the Interim Agreement by 15 countries to form the International Telecommunications Satellite Consortium (later designated as Intelsat)."[7]

"As the 1970s began, nations around the world raced to develop rockets and launch satellites as a demonstration of scientific prowess and national pride."[8] In 1970, China and Japan joined the Soviet Union and the United States as the third and fourth countries to launch satellites into orbit on their own rockets. The NATO Alliance began its space activities in 1970 with the launch of the NATO 1 communications satellite. Today, "a domain previously dominated by just two countries now involves more than fifty national space agencies, even as the list of countries setting their sights on space continues to grow."[9]

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[3] Major General John L. Barry, USAF and Col. Darrell L. Herriges, USAF, "Aerospace Integration, Not Separation," *Aerospace Power*, Summer 2000.

[4] Ibid.

[4] Ibid.

[5] Paul J. Bracken, *The Command and Control of Nuclear Forces*, (New Haven: Yale University Press, 1983), 21-22.

[5] Paul J. Bracken, *The Command and Control of Nuclear Forces*, (New Haven: Yale University Press, 1983), 21-22.

[6] Society of Satellite Professionals International (SSPI), http://www.sspi.org/?Static_Timeline (registration

[6] Society of Satellite Professionals International (SSPI), http://www.sspi.org/?Static_Timeline (registration required), accessed 30 October 2013.

[7] Ibid.

[8] Ibid.

[9] M. Ansdell, L. Delgado, and D. Hendrickson, "Analyzing the Development Paths of Emerging Spacefaring Nations: Opportunities or Challenges for Space Sustainability?," April 2011, p. 1, http://www.gwu.edu/~spi/assets/docs/Ansdell%20Delgado%20Hendrickson_Final.pdf, accessed 30 October 2013.

For the first 25 years of its history, there was no centralized joint command structure for United States space operations. Instead, military space systems were assigned to various service commands and served in a supporting role, providing tactical warning of ballistic missile launches, weather data, and satellite communications. In 1982, the U.S. Air Force recognized the need to consolidate its space operations and transferred its space systems from SAC and other commands to the newly established Air Force Space Command (AFSPC). The U.S. Navy followed suit in 1983 with the establishment of Naval Space Command and the U.S. Army began efforts to establish an Army Space Command in 1984. Finally, in 1985, the Joint Chiefs of Staff confirmed the ever-increasing value of military space systems by creating a new unified command — United States Space Command (USSPACECOM) — to consolidate space operations planning and execution in support of combatant commanders, the President, and the Secretary of Defense. Since the U.S. Air Force controlled roughly 85-90% of the assets, personnel, and budget for space operations, the commander of AFSPC was multi-hatted as the Commander-in-Chief, USSPACECOM, and as the Commander-in-Chief, NORAD.

Six years later, in 1991, space systems came to age over the featureless sands of the Middle East. In fact, the use of U.S. space assets was so widespread that Air Force Chief of Staff General Merrill McPeak called the conflict "the first space war."[10] Space assets provided coalition forces with vital communications, missile warning, navigation, reconnaissance, and weather information. In short, they provided "information dominance."[11] U.S. forces were able to observe the whole theater of operations and provide warning of Iraqi troop movements and Scud launches. In addition, U.S. forces were able to identify targets and navigate precisely to those targets with minimal losses to friendly forces. Once on station, air assets launched satellite guided precision munitions to destroy their targets with unprecedented accuracy.

While the importance of space assets was exploding, the arena of nuclear deterrence was about to change forever with the fall of the Soviet Union. On June 1, 1992, after nearly half a century of nuclear deterrence against Soviet aggression, SAC and the JSTPS faded into Cold War history. That same day, United States Strategic Command (USSTRATCOM) was established.

With the establishment of USSTRATCOM, all planning, targeting, and employment of nuclear weapons came under the control of a single combatant commander. Although space forces had previously been consolidated under the commander of USSPACECOM, command and control of U.S. space forces remained fragmented. Space forces were still organized, planned, and tasked based on their warfighting support functions. Space surveillance units responded to taskings from the USSPACECOM Space Control Center while missile warning units (many of which also perform space surveillance) responded to taskings from the USSPACECOM/NORAD Missile Warning Center. These same units, along with space launch and satellite control units, also responded to administrative taskings from AFSPC.

With the growing importance of military space capabilities following Operation DESERT STORM, the need to centralize command and control of space forces around a warfighting construct emerged. In April 1994, 14th Air Force (14 AF) was designated as USSPACECOM's operational service component for Air Force space operations – U.S. Space Command Air Forces (USSPACEAF). While 14 AF was already responsible for ensuring the readiness of assigned

[10] General Merrill A McPeak, USAF, in a speech to the 9th Space Symposium, 15 Apr 1993, *Space Trace*, May 1993.

[11] Ibid.

forces, the new designation of USSPACEAF brought the added responsibility of planning and executing assigned space missions, bringing the vast majority of United States space effects to the battlespace. However, the USSPACEAF commander (COMSPACEAF) had no way to command and control his or her forces (28 space operations systems operated by more than 12,000 people from 155 units at 44 locations in 13 time zones) because all tasking as well as command and control was previously accomplished by the USSPACECOM/NORAD Missile Warning Center and Space Control Center.

To fix the problem, plans were made to establish a 24-hour operations center at Vandenberg AFB, California. The USSPACEAF Space Operations Center (SOC) was intended to be similar to Air Operations Centers (AOCs) found at other numbered air forces; a single hub to fuse intelligence, force status, combat planning, combat operations, and battle staff support. The 614th Space Operations Squadron (614 SOPS) was subsequently established to operate and maintain the USSPACEAF SOC.

The 614 SOPS began limited operations in April 1996 with a staff of 37 and a temporary facility consisting of a few personal computers, telephones, and fax machines. By 2003, more than 130 personnel were assigned to operate and maintain a state-of-the-art operations center, along with four Satellite Communications (SATCOM) Support Centers at Peterson AFB, Colorado; MacDill AFB, Florida; Stuttgart, Germany; and Wahiawa, Hawaii. The SOC was redesignated an Aerospace Operations Center in 1999 in an effort to better integrate with the Combat Air Forces and in 2001, the U.S. Air Force implemented the standardized term of Air and Space Operations Center (AOC), after which the SOC became known as the Space AOC.

During Operations DESERT FOX, ALLIED FORCE, ENDURING FREEDOM, and IRAQI FREEDOM, personnel of the Space AOC worked with theater AOCs to enhance mission planning, targeting, combat search and rescue, theater missile defense, GPS-aided munitions employment, intelligence collection, and communications. USSPACECOM and 14 AF also deployed personnel to the U.S. Central Command Joint Operations Center in Florida and the U.S. Central Command Air Forces AOC in Saudi Arabia to enhance in-theater space expertise.

The Space AOC became the focal point for integrating and employing joint space power in global operations, with Army and Navy liaisons integrated into the Air Force organization. It was comprised of three core divisions: Strategy, Combat Plans, and Combat Operations. The Strategy division concentrated on long-range space operations planning, translating Commander's guidance and campaign objectives into an executable strategy. The Combat Plans division concentrated on near-term space operations planning, transforming mission priorities and Commander's intent into specific tasks by producing and disseminating daily Space Tasking Orders to all assigned forces. The Combat Operations division ensured mission accomplishment by monitoring force status and directing real-time execution of the Space Tasking Order through Wing Operations Centers. Various specialty teams, such as security forces, weather, intelligence, and Special Technical Operations supported the overall operation.

Following the terrorist attacks on September 11, 2001, the United States Department of Defense reassessed its combatant command structure. To meet future national security challenges, the Department of Defense made two key changes: 1) the establishment of U.S.

Northern Command (USNORTHCOM) to consolidate homeland defense and civil support functions; and 2) the merger of USSPACECOM and USSTRATCOM in order to combine the synergies of "the U.S. legacy nuclear command and control mission with … space operations," information operations, and global strike capabilities.[12]

The *new* USSTRATCOM became responsible for attack warning, missile defense, and long-range strategic attacks. Deputy Secretary of Defense Paul Wolfowitz called the merger "a transformation that will improve our command and control, our intelligence and our planning — in short, a fundamental step forward to better meet the security environment that will define the 21st Century."[13]

On October 1, 2002, U.S. Strategic Command and U.S. Space Command were both disestablished and a new U.S. Strategic Command stood up at Offutt AFB responsible for full-spectrum global strike; space operations; information operations; global missile defense; global command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR); and combating weapons of mass destruction.[14] To accomplish these missions, the command established a variety of sub-unified and functional component commands.

In May 2005, the Space AOC was redesignated as the Joint Space Operations Center (JSpOC) and in July 2006, USSTRATCOM established a new Joint Functional Component Command for Space (JFCC SPACE), headquartered at Vandenberg AFB, California. These changes signified that space operations had transitioned from service-specific operations to a truly joint operational structure comprised of all U.S. military services.

Through the JSpOC, JFCC SPACE coordinates operational-level space planning, integration, and coordination to ensure unity of effort and executes continuous, integrated space operations to deliver theater and global effects in support of national and combatant commander objectives.[15] JFCC SPACE also employs the Joint Navigation Warfare Center (JNWC), located at Kirtland Air Force Base, New Mexico, to enable space-based positioning, navigation, and timing superiority for the Department of Defense and interagency coalition partners as well as the Missile Warning Center (MWC), located at Cheyenne Mountain Air Force Station, Colorado, to coordinate, plan, and execute world-wide missile, nuclear detonation, and space re-entry event detection to provide timely, accurate, and unambiguous strategic warning in support of the United States and Canada.[16] In addition to executing these functions, the Commander, JFCC SPACE (CDR JFCC SPACE) is also designated as the U.S. Global Space Coordinating Authority (GSCA), integrating and supporting space requirements of U.S. combatant commanders worldwide.

Other countries have also realized the need to establish operational-level space centers. For example, the United Kingdom established a Space Operations Coordination Centre at Royal Air Force Station High Wycombe; Spain established a European Union Satellite Centre in

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[12] United States Strategic Command website, http://www.stratcom.mil/about/, accessed 25 September 2013.

[13] Wolfowitz, Paul, U.S. Deputy Secretary of Defense, in a speech given at Offutt AFB, Omaha, NE, 1 October 2002, http://www.defense.gov/news/newsarticle.aspx?id=42665, accessed 25 September 2013.

[14] United States Strategic Command website, http://www.stratcom.mil/about/, accessed 25 September 2013.

[15] "JFCC Space Fact Sheet," http://www.stratcom.mil/factsheets/JFCC_-_Space/, accessed on 25 September 2013.

[16] Ibid.

Torrejon to analyze satellite imagery data;[17] and Germany established a Space Situational Awareness Center in Uedem.[18] However, none yet rival the breadth and depth of U.S. capabilities.

The Importance of Space Capabilities to NATO

Why are space capabilities important to NATO? Space capabilities, and more specifically the effects provided by those capabilities, are proven force multipliers. They provide global communications; precise positioning, navigation, and timing (PNT); environmental monitoring; space-based intelligence, surveillance, and reconnaissance (ISR); and missile warning.[19] The United States "has realized for some years now how important space capabilities are and how dependent it has become on them. NATO is just coming to this same conclusion."[20]

> Space capabilities provide…unprecedented advantages in national decision-making, military operations, and homeland security. Space Systems provide national decision-makers with unfettered global access and create a decision advantage by enabling a rapid and tailored response to global challenges. Moreover, space systems are vital to monitoring strategic and military developments as well as supporting treaty monitoring and arms control verification. Space systems are also critical in our ability to respond to natural and man-made disasters and monitor long-term environmental trends. Space systems allow people and governments around the world to see with clarity, communicate with certainty, navigate with accuracy, and operate with assurance.
>
> United States National Security Space Strategy

The ability of NATO to exploit space effects during a conflict and prevent adversaries from doing the same is critical to the success of military operations. As Brigadier General Massimo Panizzi, NATO International Military Staff Public Affairs and Strategic Communications Advisor stated,

> Free access to global commons – cyber, space, land, maritime – is fundamental to NATO's ability to operate. It is inconceivable that we could operate effectively should our forces be denied the use of even one of these four domains. We must continue to work to assure the freedom of these global domains.[21]

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[17] European Satellite Centre, http://www.satcen.europa.eu/, accessed 31 October 2013.

[18] Peter B.Selding, "French Defense Ministry Now Says it Supports European SSA Effort," *Space News*, 6 May 2013, http://www.spacenews.com/article/military-space/35175french-defence-ministry-now-says-it-supports-european-ssa-effort, accessed 31 October 2013, and Amy Svitak, "EU Aims for Space Situational Awareness Network," *Aviation Week and Space Technology*, http://www.aviationweek.com/Article.aspx?id=/article-xml/AW_08_05_2013_p27-603051.xml&p=3, accessed 31 October 2013.

[19] Joint Publication 3-14, Space Operations, 29 May 2013, http://www.dtic.mil/doctrine/new_pubs/jp3_14.pdf, accessed 27 September 2013.

[20] Air Commodore Jan A. H. van Hoof, Royal Netherlands Air Force, "Coalition Space Operations – A NATO Perspective," *High Frontier* 6, (February 2010) No. 2, 7.

[21] Brigadier General Massimo Panizzi, IMS Public Affairs and Strategic Communications Advisor, in a speech given 16 November 2011 on the emerging security challenges under NATO's New Strategic Concept,

In fact, space assets provide such "a critical (and integrating) infrastructure and capability...essential to day-to-day NATO operations" that "NATO ACT has defined Space Capability Preservation (SCP) as one of [its] Long Term Capability Requirements (LTCR)."[22] As such, NATO must focus not just on the importance of space capabilities, but on space operations as a whole; that is, the provision of space forces by member nations, the integration of those forces into NATO plans, and the ability of NATO to coordinate and control those forces in support of NATO operations.

Despite its importance, "there has been very little guidance or governance on space in NATO."[23] NATO does not currently have a space policy, a military space strategy, a space doctrine document, or space Joint Tactics, Techniques and Procedures (TTPs).[24] In fact, as the JAPCC noted in their 2009 Space Operations Assessment, one often hears remarks such as "Why does NATO need to talk about Space now? We already have SATCOM, ISR, GPS, and weather data, isn't that all we need?" and "NATO doesn't have a Space Policy; why do we need one now?"[25] The answer is that in order to fully exploit Allied space capabilities and prepare for potential loss of those capabilities, this type of guidance and governance must be developed, along with the operational expertise, architecture, and C2 infrastructure to integrate and execute operations.

In 2007, Allied Command Transformation requested that the NATO Joint Air Power Competency Center (JAPCC) assess NATO space operations, identify gaps, and provide recommendations on the way ahead for both the short and the longer term. In 2009, the JAPCC delivered a NATO Space Operations Assessment providing 23 recommendations, based on a number of identified gaps.[26] Key among these findings was the need to establish a holistic approach to developing and integrating NATO space capabilities; the need to establish NATO space policy, doctrine, and strategy; the need to develop space expertise throughout NATO; the need to integrate multi-national requirements, standards, capabilities, and security classification structures; and the need to establish an overarching space office to oversee strategic execution of these functions.[27]

Moreover, NATO's 2009 Strategic Concept Document, titled "Active Engagement, Modern Defence," highlights that as NATO evolves "to be effective in a changing world, against new threats, with new capabilities and new partners," the proliferation of ballistic missiles poses "a real and growing threat to the Euro-Atlantic area" while the development of laser weapons and electronic warfare technology that could impede access to space capabilities "will impact NATO military planning and operations."[28] As such, NATO must ensure it "has the full range of

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http://www.nato.int/cps/en/natolive/opinions_81033.htm?selectedLocale=en, accessed 27 September 2013.

[22] NATO Space Capability Preservation (SCI-238) website, http://www.cso.nato.int/ACTIVITY_META.asp?ACT=2089, accessed 30 October 2013.

[23] van Hoof, "Coalition Space Operations – A NATO Perspective," 9.

[24] Nina-Louisa Remuss, ESPI Associate Fellow, "NATO and Space: Why is Space Relevant for NATO?," *ESPI Perspectives* (October 2010), No. 40, 5.

[25] NATO Space Operations Assessment, Joint Air Power Competency Center, Revised January 2009, p. 6.

[26] van Hoof, "Coalition Space Operations – A NATO Perspective," 9.

[27] NATO Space Operations Assessment, chapter 5.

[28] "Active Engagement, Modern Defence," Strategic Concept for the Defence and Security of the Members of the

capabilities necessary to deter and defend against any threat to the safety and security of our populations"[29] across the collective security, crisis management, and cooperative security spectrum. "Space is becoming increasingly congested, contested, and competitive"[30] and "the history of mankind has shown that wars will be fought wherever commerce and business interests are contested."[31] Exploitation and collective defense of space capabilities are absolutely critical to NATO if the Alliance is to be ready for any future conflict.

In 2012, the U.S. Air Warfare Center hosted the Schriever Wargame International, providing NATO with an "unprecedented opportunity to explore combined space operations within a NATO construct."[32] A key objective of the wargame, which included participants from Canada, Denmark, France, Germany, Italy, the Netherlands, Turkey, the United Kingdom, and the United States, as well as Australia, "was to identify the challenges to, and opportunities for, space support to [NATO Joint Force Command (JFC)] operations."[33]

Key findings from the wargame included:

- Orchestrating execution of space capabilities to form an element of the scheme of manoeuvre via an authority such as SCA requires active planning between [the Supreme Headquarters Allied Powers Europe (SHAPE)], the JFC, and the various capability providers.
- Tailoring Space Support to theatre operations is a shared and continuous partnership between the theatre and the various providers, implying the need for a common operational language.
- The use of space warrants evaluation by planners during Centre of Gravity analysis and may result in the need for personnel from the strategic to the tactical level to anticipate protective measures in advance.
- The NATO Command Structure has only coincidental space expertise but various NATO member states already have space experts in their forces.[34]

However, the urgency of these aforementioned recommendations are not just hypothetical. Many real-world lessons have been learned during the 12 year long NATO-led International Security Assistance Force mission in Afghanistan. Chief among them are impediments to the sharing of intelligence information at common security classification levels; lack of processes and procedures to planning, requesting, and exploiting NATO space

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North Atlantic Treaty Organisation adopted by Heads of State and Government in Lisbon, 19 November 2010, http://www.nato.int/cps/en/natolive/official_texts_68580.htm, accessed 30 September 2013.

[29] Ibid.

[30] National Security Space Strategy, pp 1, January 2011, http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf, accessed 1 October 2013.

[31] van Hoof, "Coalition Space Operations – A NATO Perspective," 10.

[32] MAJ Philip Verroco, USAF, "Schriever Wargame 2012 International: Seizing an Unprecedented Opportunity," JAPCC Flyer, Edition 5, May 2012.

[33] Ibid.

[34] Ibid.

capabilities; the lack of space expertise in key NATO organizations; and lack of operational and doctrinal guidance for space operations.[35] These lessons learned point to the urgent need for NATO to draft a space operations doctrine; develop processes and procedures for requesting and integrating member nation space capabilities into NATO operations, to include data sharing agreements; cultivate resident space expertise; and incorporate space into all future NATO exercises and wargames.

Taking these lessons to heart, General Stephane Abrial, Supreme Allied Commander Transformation, with the support of SACEUR, formally established a NATO Bi-Strategic Command Space Working Group on 21 September 2012. Among other things, the working group's assigned tasks include developing direction and guidance for space support to NATO operations and recommending requirements (i.e., doctrine, organization, training, materiel, leadership and education, personnel, facilities, and interoperability) to improve space support to NATO operations.[36] To date, the working group has held three meetings (one in 2012 and two in 2013) with plans to provide a NATO Approach to Space Education and Training Plan by the end of 2013, a report on NATO space dependencies by early 2014, and completion of preliminary actions by 2015.[37] "This mandate is the first-ever space focused framework at the MC level that clearly focuses on operational issues and not on policy."[38] While a definite step in the right direction, this roadmap timeline appears painstakingly slow.

Space Warfighting Doctrine

Doctrine is a compilation "of agreed upon fundamental principles that guide the employment of forces … in coordinated action toward a common objective."[39] Space forces are critical to fighting and winning modern wars and employment of space capabilities requires special doctrinal focus.

As former U.S. Air Force Chief of Staff General John P. Jumper noted, space is different. It requires a different culture, different operating principles, and a unique respect for what it brings to the fight.[40]

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[35] Single, Thomas G., Lt Col, USAF, "New Horizons: Coalition Space Operations," *Air and Space Power Journal*, Summer 2010, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/sum10/10Single.html, accessed 3 October 2013 and Remuss, "NATO and Space: Why is Space Relevant for NATO?,"5.

[36] Memorandum from General Stephane Abrial, SACT to General Knud Bartels, Chairman, NATO Military Committee, 21 September 2012, http://www.act.nato.int/images/stories/events/2012/nato_space/letter_sact.pdf, accessed 16 November 2013.

[37] NATO Bi-Strategic Command Space Working Group Progress Report, 23 May 2013, http://www.act.nato.int/images/stories/events/2012/nato_space/progress_report.pdf, accessed 16 November 2013 and the associated roadmap at http://www.act.nato.int/images/stories/events/2012/nato_space/workplan.pdf, accessed 16 November 2013.

[38] Interview with Newsham, Trevor, J., Maj, USAF, Course Director and Staff Officer, NATO School, Oberammergau, Germany, 14 November 2013.

[39] Definition of multi-national doctrine as found in the U.S. Department of Defense Dictionary of Military Terms, http://www.dtic.mil/doctrine/dod_dictionary/data/m/3216.html, accessed 18 December 2013.

[40] General John P. Jumper, USAF, in an article by SSgt. A. J. Bosker, USAF, *Air Force Print News*, 5 October 2001.

> We have to … pay great attention to combining the effects of air and space because in the combining of those effects, we will leverage this technology we have that creates the asymmetrical advantage for our commanders. …Air and space capabilities have to work together to bring the right war-fighting effect to the right target at the right time.[41]

There are currently three NATO documents that address planning and execution of space operations. The first is Allied Joint Publication (AJP) 3.3, Air and Space Operations which, with regards to space operations, is limited to just an overview of space mission areas; the second is the Bi-Strategic Command (Bi-SC) Functional Planning Guide for Space Operations which provides planning instructions for integrating space into operations; and the third document is ACT DIR 75-2-N, Space Operations Joint Functional Area Training Guide (JFATG).[42]

While this may seem like comprehensive guidance for NATO, it is not. There is no NATO Space policy, no military Space strategy, no Space doctrine document, and no Space Joint Tactics, Techniques and Procedures documents."[43] …Strategic and operational planners are challenged to find the appropriate guidance directing the integration of space capabilities and effects."[44] Moreover, AJP 3.3 "is limited in scope. It's more of an educational document that helps nations speak a common language when it comes to the space operations mission areas…and is very broad."[45] As such, the existing guidance is insufficient and a more comprehensive NATO space doctrine document should be developed.

When discussing doctrine, one must remember that NATO is an alliance of 28 nations and that member countries retain their full sovereignty and bring with them their own history, interests, and doctrine. That said, it can be argued that the United States has the vast majority of space capabilities, space operations personnel, and space expertise, as well as the most mature space doctrine among the Allies. Since doctrine is "what we believe to be true about the best way to do things based on the evidence to date,"[46] it would be wise for NATO to reference United States space doctrine as a starting point for development of related Allied doctrine.

Given its long history with military space operations, the United States has developed associated doctrine documents at both the service component and joint operations levels. The following doctrinal concepts are derived from U.S. Air Force Doctrine Document (AFDD) 3-14, Space Operations; United States Joint Publication (JP) 3-14, Space Operations; AFDD 6-0, Command and Control; and JP 3-16, Multi-National Operations[47] and have been modified for

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[41] General John P. Jumper, USAF, "A Word from the Chief: Why 'Air and Space'?"*Air and Space Power Journal International*, 2002, http://www.airpower.maxwell.af.mil/apjinternational/apj-p/2002/3tri02/jumper.htm, accessed 1 October 2013.

[42] NATO Space Operations Assessment, Joint Air Power Competency Center, revised January 2009, para 3.3.

[43] Ibid, para 3.6.

[44] Ibid.

[45] Interview with Maj Trevor J. Newsham, USAF, Course Director and Staff Officer, NATO School, Oberammergau, Germany, 14 November 2013.

[46] Air Force Basic Doctrine, Chapter 1, p. 1, https://doctrine.af.mil/download.jsp?filename=V1-D02-Doctrine-Defined.pdf, accessed 18 December 2013.

[47] Air Force Doctrine Document 3-14, Space Operations, 19 June 2012, http://static.e-publishing.af.mil/production/1/af_cv/publication/afdd3-14/afdd3-14.pdf, accessed 27 September 2013; Joint Publication 3-14, Space Operations, 29 May 2013, http://www.dtic.mil/doctrine/new_pubs/jp3_14.pdf, accessed 27 September 2013; Air Force Doctrine Document 6-0, Command and Control, 1 June 2007 incorporating Change 1, 28

potential consideration by NATO. (Note that in the NATO context, the term "joint" refers to multinational operations forces as opposed to multi-service operations.) This discussion is not intended to be an all-inclusive doctrinal document, but rather to highlight key considerations for the integration and employment of NATO space capabilities.

FUNDAMENTALS OF MILITARY SPACE OPERATIONS

- ***Space Contributions to Joint Operations:*** "Space capabilities have proven to be significant force multipliers when integrated into military operations. …To facilitate effective integration, joint force commanders (JFCs) and their staffs should have a common and clear understanding of how space forces contribute to joint operations and how military space operations should be integrated with other military operations to achieve objectives."[48]
- ***Operational Considerations for Space:*** Space forces often support multiple users simultaneously. "Space capabilities should be integrated and synchronized by the supported commander into specific joint offensive and defensive operations, operation and campaign planning, and into their concept of operations (CONOPS), operation plans (OPLANs), and operation orders. … This requires extensive coordination, planning, and the early identification of requirements and capabilities."[49]
- ***Space Vulnerabilities:*** "Space is becoming increasingly congested, contested, and competitive."[50] Satellites are vulnerable to both unintentional and purposeful interference. "Commanders should consider the possibility of hostile actions from state and non-state actors intended to deny friendly forces access to, or use of, space capabilities while developing strategic estimates, plans, and other documents and planning future operations and activities. They also should anticipate the proliferation and increasing sophistication of space capabilities and products with military utility that could be used by any adversary for hostile purposes. Potential adversaries no longer have to develop large infrastructures to obtain or interfere with space capabilities. Today, many capabilities can be easily purchased. Options available to exert influence or prevent an adversary's access to space capabilities include diplomatic, informational, military, and economic measures."[51]
- ***Space Environment:*** The space environment has unique characteristics that impact military operations. These include the need to follow the laws of physics and orbital mechanics; perturbations caused by gravity and atmospheric drag; and susceptibility of systems to solar flares, charged particles, electromagnetic noise, ionospheric interference, and other natural phenomena.[52]

July 2011, http://static.e-publishing.af.mil/production/1/af_cv/publication/afdd6-0/afdd6-0.pdf, accessed 27 September 2013 at; and Joint Publication 3-16, Multi-national Operations, 16 July 2013, http://www.dtic.mil/doctrine/new_pubs/jp3_16.pdf , accessed 27 September 2013.

[48] "Joint Publication 3-14: Space Operations," ix.

[49] Ibid, pp. I-7.

[50] Ibid, pp. I-8.

[51] Ibid, pp. I-2.

[52] Ibid, pp. I-8.

SPACE MISSION AREAS

- ***Space Situational Awareness:*** Space situational awareness (SSA) involves actions taken to develop current and predictive knowledge of space systems; the environment in which they operate; and the activities, actions, and intent of friendly and adversary space forces across the spectrum of conflict in order to provide a common operating picture and the ability to provide threat warning and assessment. SSA is dependent on integrating intelligence, surveillance, and reconnaissance (ISR) of on orbit satellites; environmental monitoring, processing and analysis; status of Allied space systems; and analysis of the space domain. It is fundamental to all space activities and is crucial to orbital safety and protection of Allied space capabilities. [53]
- ***Space Force Enhancement:*** Space force enhancement operations increase joint force effectiveness by enhancing operational awareness and providing critical joint force support functions. Space force enhancement is comprised of space-based ISR; ground and space-based missile warning and tracking; environmental monitoring; satellite communications (SATCOM); and Position, Navigation, and Timing (PNT). [54]
- ***Space Support:*** The space support mission area includes the essential capabilities, functions, activities, and tasks necessary to operate and sustain all elements of space forces throughout the range of military operations. It includes spacelift operations to deliver satellites, payloads, and material into space; satellite operations conducted to maneuver, configure, operate, and sustain on-orbit assets; and reconstitution of space forces to replenish lost or diminished space capabilities by repositioning, reconfiguring, and augmenting space assets. [55]
- ***Counter-Space:*** Counter-Space operations support freedom of action in space for friendly forces and when necessary, defeats adversary efforts to interfere with or attack Allied space systems. [56] It consists of offensive and defensive operations and includes both active and passive means. Offensive Counter-Space (OCS) are measures taken to prevent an adversary's hostile use of space capabilities or to negate an adversary's ability to interfere with or attack Allied space systems. Defensive Counter-Space (DCS) are operations conducted to preserve the ability to exploit space capabilities while protecting friendly space capabilities from attack, interference, or unintentional hazards.[57]

[53] Air Force Doctrine Document 3-14, Space Operations and Joint Publication 3-14, Space Operations.

[54] Ibid. N.B. While ground and space-based space assets support ballistic missile defense, associated doctrinal guidance is outside the scope of this paper.

[55] Ibid.

[56] N.B. United States Joint Doctrine and United States Air Force Doctrine use the terms Space Control, Offensive Space Control, and Defensive Space Control. However, I prefer the terms Counter-Space, Offensive Counter-Space, and Defensive Counter-Space to highlight the parallels to Air Doctrine, namely the terms and definitions of Counter-Air, Offensive Counter-Air, and Defensive Counter-Air.

[57] Air Force Doctrine Document 3-14, Space Operations and Joint Publication 3-14, Space Operations.

COMMAND AND CONTROL OF SPACE FORCES

- ***Space and the Principles of Joint Operations***: SACEUR objectives and the needs of supported commander should drive the conduct of theater space operations. Member nations should prioritize space capabilities and make apportionment and allocation recommendations for their systems in coordination with supported commanders. [58]
- ***Command Relationships:*** Joint space forces and capabilities are integral parts of military operations worldwide, requiring multiple command relationships between force providers and supported commanders. SACEUR should designate a supported commander to manage daily space operations and outline command relationships.[59]
- ***Centralized Control and Decentralized Execution:*** Centralized control maximizes combat potential by integrating limited assets during operational planning. It also minimizes fragmentation of effort and ensures coherent objectives. Since directing the detailed actions of a large number of interacting forces is too difficult for a single commander to accomplish alone, decentralized execution is usually necessary. Decentralized execution ensures effective employment of limited assets, allows tactical adaptation, and accommodates the different employment concepts and procedures in a joint environment. This requires "two-way information flow among commanders, operators, and combat support elements that must be effectively integrated to achieve the desired combat effects."[60]
- ***Space Coordinating Authority:*** A supported commander should be delegated space coordinating authority (SCA) in order to integrate space capabilities and coordinate joint space operations in the operational area. Based on the complexity and scope of operations, the supported commander can either retain SCA or designate a subordinate commander (or other individual) as the SCA.[61] The NATO individual assigned to be the SCA "should have a theater-wide perspective and thorough understanding of integrating space operations with all other military activities" and "serves as the focal point for gathering space requirements from the JFC's staff and each component commander. This coordination provides unity of effort for space operations in support of the JFC's campaign. Space requirements may include requests for space forces (e.g., deployed space forces), requests for space capabilities (e.g., support to personnel recovery operations), and requests for implementation of specific command relationships."[62] The NATO individual assigned to be the SCA should gather operational requirements that could be satisfied by space capabilities; develop and coordinate a list of recommended space requirements for the supported commander based on joint force objectives to ensure that space activities are coordinated, deconflicted, integrated, and synchronized; and facilitate the planning and conduct of NATO space operations. To execute these duties effectively, the supported commander should establish a joint space element comprised of multi-national space experts.

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[58] Joint Publication 3-14, Space Operations.

[59] Ibid, pp. III-1.

[60] Air Force Doctrine Document 6-0, p. 13.

[61] Joint Publication 3-14, Space Operations.

[62] Air Force Doctrine Document 3-14, p. 14.

- ***NATO Space Expertise:*** NATO should have experienced "space operators resident on staffs at multiple echelons to serve as day to day advisors for national and foreign space capabilities (military, civil, and commercial)."[63] These individuals can also assist theater space operations in support of the SCA in developing, collecting, and prioritizing space requirements.[64]
- ***Role of Non-Military Space Capabilities:*** SACEUR and supported commanders will have requirements that may need to be supplemented through civil and commercial capabilities in addition to assigned and allocated military capabilities. The SCA should develop processes and mechanisms to coordinate with required civil and commercial entities. [65]

PLANNING, EXECUTION, AND ASSESSMENT

- ***Operations Plans:*** NATO commanders should consider space capabilities when selecting alternatives to satisfy mission needs, develop and articulate military requirements for space and space-related capabilities, and provide prioritized theater space requirements. Commanders should address space operations in all types of plans and orders and those plans should address how to effectively integrate capabilities, counter an adversary's use of space, and maximize use of limited space assets. In addition, plans should describe how space operations support the commander's stated objectives, how the adversary employs its space forces, and outline the process and procedures through which additional support will be requested.[66]
- ***Key Planning Considerations:*** Space forces are force multipliers across the spectrum of conflict and bring enhanced global presence, perspective, precision, and flexibility to military operations. As such, space assets must be integrated into deliberate and crisis action planning, as well as operations planning, combat operations, and time sensitive targeting to ensure timeliness of effects. Doing so "presents unique planning and operational considerations that affect friendly, adversary, and neutral space forces alike."[67] Operational planners must understand the limited number of resources available, the operational and legal considerations for employment of space capabilities, the threats to the use of those systems by an adversary, and the distinct challenges with space force reconstitution.[68] "The space planner must also understand what can be done to limit an adversary's use of space" capabilities and how to protect Allied use of space.[69]
- ***Operational Assessment:*** Commanders should continually assess employment of space capabilities to determine the effects and impacts on achieving JFC objectives. Assessment should be a continuous process focused on determining if the right space capabilities are being employed in the right manner and if we're measuring the right things to determine success. Specifically, was the intended action accomplished, did it produce the desired

[63] Joint Publication 3-14, Space Operations, p. xii.
[64] Ibid, p. xii.
[65] Ibid, pp. III-4.
[66] Ibid, pp. V-1.
[67] Ibid, pp. V-5.
[68] Ibid.
[69] Ibid.

effect, and is re-execution required? To ensure the principles of objective and unity of effort are properly executed, it is critical that this operational assessment be disseminated through a two-way feedback mechanism to assigned and attached space forces.[70]

NATO Space Capabilities

NATO has been active in space since 1970, beginning with the launch of its NATO I, II, III, and IV series of communications satellites. However, the 28-nation Alliance largely relies on the military and civilian capabilities of its member nations, fifteen of which are active in space (Canada, the Czech Republic, Denmark, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, and the United States).[71] Although NATO does not conduct space operations, its members do, and the Alliance must understand what capabilities are available as well as plan for and ensure those space capabilities are properly integrated into NATO operations.

Space situational awareness capabilities enable an understanding of friendly and adversary space systems, the environment in which they operate, and the intent of an adversary in order to provide a common operating picture. It includes space surveillance and reconnaissance systems, such as electro-optical telescopes, mechanical radars, and phased array radars to track the 23,000 objects currently in Earth orbit; environmental monitoring systems (primarily to monitor the space environment); and intelligence functions to assess adversary space capabilities and intent. SSA is also critical in helping friendly forces determine why their satellite systems may be malfunctioning, whether it is due to system anomalies, environmental conditions, or hostile action so that appropriate measures may be taken.

Space force enhancement capabilities provide critical joint force support functions. This includes a wide variety of space-based ISR systems; ground and space-based missile warning and tracking systems; space-based environmental monitoring systems (primarily of the terrestrial environment); communications satellites; and Position, Navigation, and Timing (PNT) systems such as the Global Positioning System (GPS). These systems provide an asymmetric advantage by enabling tactical warning and attack assessment, over-the-horizon communications, precision navigation and weapons engagement, friendly force tracking, and support to personnel recovery operations.

Space support capabilities enable operation and sustainment of space forces. These include spacelift capabilities for force regeneration, satellite command and control capabilities to sustain satellites on orbit, and conjunction analysis for active spacecraft to ensure orbital safety, both manned and unmanned.

Counter-Space capabilities prevent an adversary's hostile use of space capabilities or negate an adversary's ability to interfere with or attack Allied space systems while protecting friendly space capabilities from attack, interference, or unintentional hazards. Offensive counter-space actions could include targeting of terrestrial nodes, communications links, or space nodes by friendly land, maritime, or air forces. Defensive counter-space actions could include measures taken to protect friendly space capabilities, detect hostile attacks on those assets, characterize the attacks, and enable responses to mitigate them.

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[70] Air Force Doctrine Document 3-14, p. 57.

[71] van Hoof, "Coalition Space Operations – A NATO Perspective," p. 10.

> Typically, forces don't know what products are available to them [and] there is not a clear…understanding of what space systems and capabilities NATO has access to. …There is a tremendous amount of existing capability if we can only connect our customers in the field with those space capabilities.[72]

To this end, the charts at Appendices 1 and 2 provide an unclassified overview of NATO member nation capabilities, both military/government as well as civil/commercial. While extensive, it is not intended as an all-inclusive list of systems nor does it list details of all capabilities. That said, NATO personnel should become familiar with the data in these appendices.

Recommendations for Command and Control

There are several options for commanding and controlling Allied space forces. Potential options include the USSTRATCOM Joint Space Operations Center; a U.S. Combined Air and Space Operations Center; a space operations center from another Allied nation; an existing NATO Combined Air and Space Operations Center; or a new NATO Space Coordination Center. The question is: which would be most effective?

Supported commanders often view C2 of space operations as analogous to theater air operations and request operational control (OPCON) or tactical control (TACON) of space forces in order to control space effects within their area of operations. Space assets, however, are not theater-specific. They can and do support multiple theaters simultaneously. Space assets deployed to or positioned over one theater may be supporting operations in a different theater. In addition, space systems are high demand/low density assets and therefore must be prioritized, deconflicted, integrated, and synchronized across all joint operations.

Keeping with the concept of centralized control and decentralized execution,[73] forces employed to achieve national objectives or produce effects across multiple theaters should not be fragmented; they are best controlled centrally. In addition, planning space operations requires specialized expertise, tools, intelligence, and communications networks. Therefore, national commanders (through their established C2 structure) should normally retain OPCON of their forces and produce effects for the supported joint force commander (JFC) via a support relationship. However, processes and procedures should be established that allow the supported commander to control the timing and tempo of space-derived effects.

One concept proposed to integrate multi-national space capabilities is to establish coalition Space Support Teams modeled after the U.S. Air Force Space Support Teams employed in the mid-late 1990s.[74] While this was a good way to begin spreading the benefits of space capabilities throughout the Combat Air Forces (CAF) during Operations JOINT ENDEAVOR, DENY FLIGHT, DESERT FOX, DESERT THUNDER and ALLIED FORCE, the teams were not universally received and accepted by the CAF. The problem was rooted in the fact that space expertise was not permanently embedded in the CAF organizational structure and was not part of

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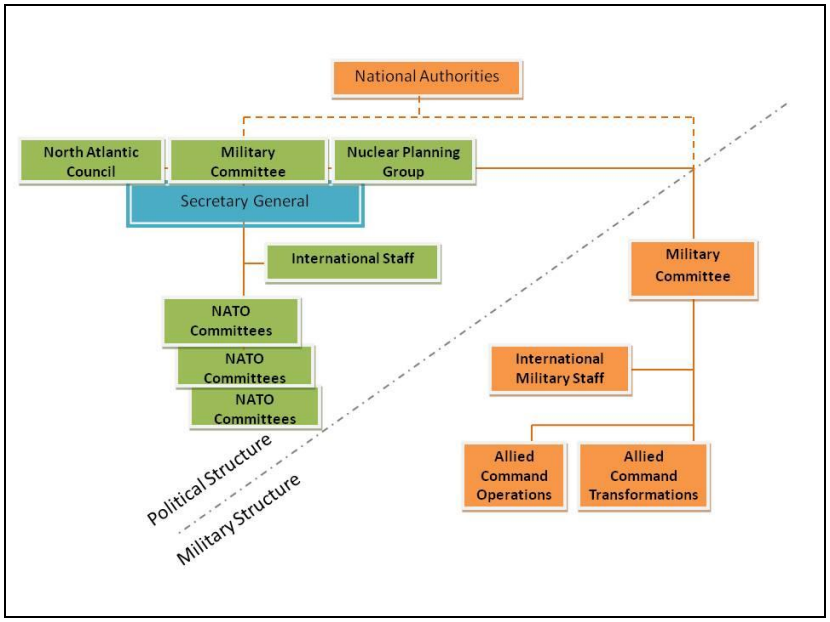
[72] NATO Space Operations Assessment, Joint Air Power Competency Center, Revised January 2009, pp. 24-25.
[73] Outlined earlier in this paper in the section on space warfighting doctrine, which begins on p. 9.
[74] Lt. Col. Thomas G. Single, USAF, "New Horizons: Coalition Space Operations," *Air and Space Power Journal*, Summer 2010, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/sum10/10Single.html, accessed 3 October 2013.

day to day operational planning. Instead, a team of "outsiders" would show up on the CAF's proverbial doorstep during a crisis and offer their expertise. To paraphrase an unnamed European Chief of Defence, this virtual presence equated to an actual absence. In other words, rotating space expertise into an organization only in times of crisis did not lead to effective integration of space capabilities. A much more effective method is to ensure space expertise is permanently established throughout NATO at the right level in the right organizations to provide command and control of Allied space operations. In order to determine where this presence should be and how C2 should be executed, one must understand the structure of NATO.

NATO is a complex organization. Political leadership is provided by the North Atlantic Council (NAC), comprised of civilian leaders from the 28 member nations: Albania, Belgium, Bulgaria, Canada, Croatia, The Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey, the United Kingdom, and the United States. While various committees and the NATO International Staff provide advice to the Secretary General, it is important to note that all 28 member nations retain full sovereignty. In addition to the NAC, there is also a Nuclear Planning Group; a Military Committee, which provides advice to the NAC and NPG; an International Military Staff (IMS); and two strategic level commands (Allied Command Transformation and Allied Command Operations).



NATO Organizational Structure Overview[75]

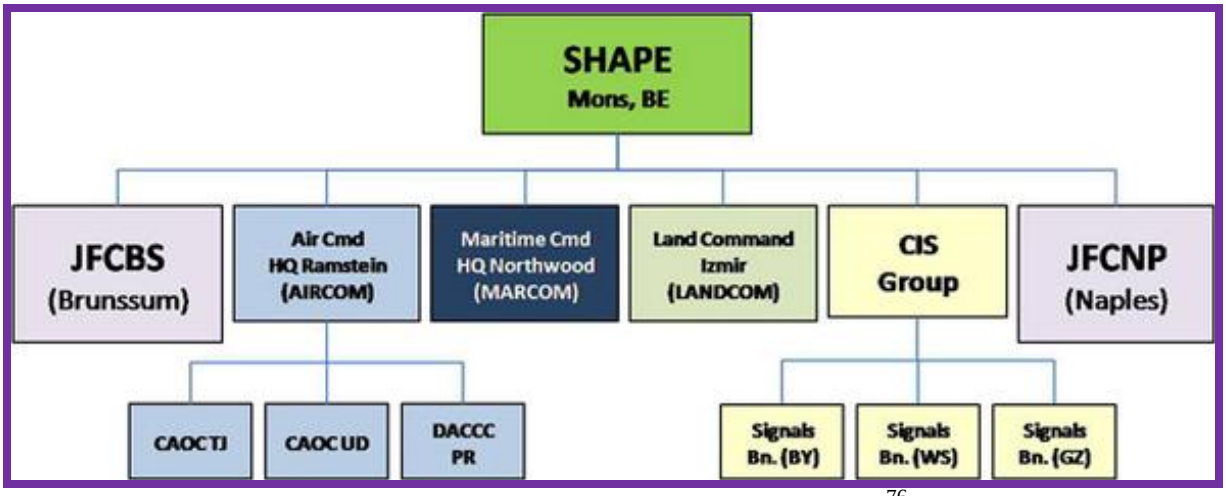
Allied Command Transformation (ACT), located in Norfolk, Virginia, is NATO's leading agent for change, facilitating and advocating continuous improvement of Alliance capabilities through a variety of education, training, and exercises. To accomplish this mission,

[75] NATO Organization Overview Chart taken from "A Global Perspective on NATO," VADM Bruce E. Grooms, Allied Command Transformation, as presented to students at the NATO School's Senior Officer Policy Course on 9 September 2013.

the Supreme Allied Commander Transformation (SACT), oversees NATO's Joint Warfare Center (JWC) in Stavanger, Norway; the Joint Forces Training Center (JFTC) in Bydgoszcz, Poland; the NATO Maritime Interdiction Operational Training Center (NMIOTC) in Souda Bay, Crete; the NATO School in Oberammergau, Germany; the Joint Analysis and Lessons Learned Center (JALLC) in Lisbon, Portugal; and 18 NATO Centers of Excellence.

Allied Command Operations (ACO), commanded by SACEUR from the Supreme Headquarters Allied Powers Europe (SHAPE) in Mons, Belgium, is comprised of two operational level Joint Force Commands; one is located in Brunssum, the Netherlands (JFC-Brunssum) and the other in Naples, Italy (JFC-Naples). Both are prepared to plan, conduct, and sustain NATO operations as required. The JFCs are no longer tied to specific regional areas of responsibility and are able to execute joint operations from their permanent locations or from a deployed headquarters, giving NATO greater flexibility in meeting the security challenges of the 21st Century. For example, JFC-Brunssum is currently focused on International Security Assistance Force (ISAF) operations in Afghanistan while JFC-Naples concentrates on the Mediterranean region.

The two JFCs are assisted by three component commands, specializing in land, maritime, and air operations. These consist of the Land Command (LANDCOM) with headquarters (HQ) in Izmir, Turkey; Maritime Command (MARCOM) with HQ in Northwood, UK; and Air Command (AIRCOM) HQ at Ramstein Air Base, Germany. Additionally, there is a NATO Communications and Information Systems (CIS) Group based in Mons, Belgium, which provides deployable communications and information systems support for ACO, as well as CIS operations and exercises planning and control. The CIS is supported by three NATO Signals Battalions located at Bydgoszcz, Poland (BY); Wesel, Germany (WS); and Grazzanise, Italy (GZ).

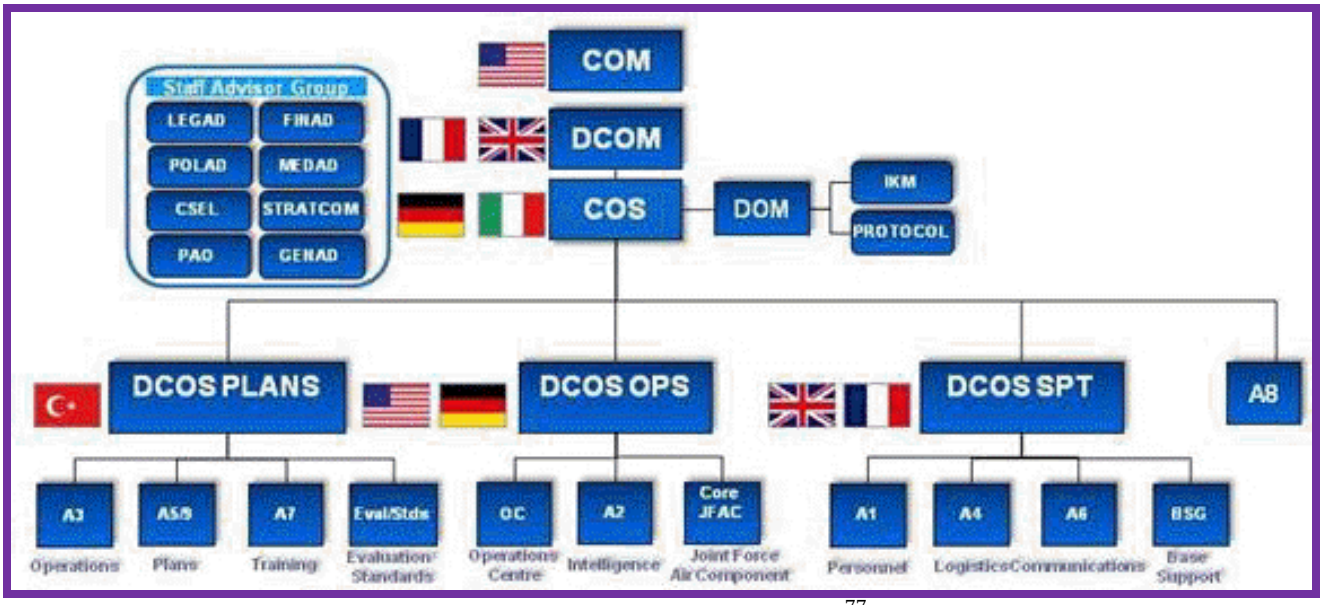


Organizational Structure of Allied Command Operations (ACO)[76]

AIRCOM's mission is to plan and direct NATO air and missile defense missions. It is also designated as NATO's focal point for Allied Air and Space advice and competency. To execute this mission, AIRCOM employs a core Joint Force Air Component (JFAC) organization

[76] NATO website, http://www.nato.int/cps/en/natolive/topics_52091.htm, accessed 23 November 2013.

to provide command and control of air operations and operates two Combined Air Operations Centers (CAOCs) located in Torrejon, Spain (TJ) and Uedem, Germany (UD) as well as a Deployable Air Command and Control Center (DACCC) in Poggio Renatico, Italy (PR).



Organizational Structure of Allied Air Command (AIRCOM)[77]

The CAOCs focus on Air Policing (AP) and Ballistic Missile Defense (BMD) related duties within the NATO Area of Responsibility. They are comprised of two parts: a Static Air Defense Center (SADC) and a Deployable Air Operations Center (D-AOC). During a crisis or combat operations, the SADC continues the AP mission while D-AOC personnel will augment the HQ AIRCOM JFAC organization, normally located at Ramstein AB, Germany.[78]

The DACCC is comprised of three elements: a Deployable Air Control Center, Recognized Air Picture Production Center/Sensor Fusion Post (DARS), responsible for controlling air missions, air traffic control, area air surveillance, and other tactical control functions; a Deployable Sensors Section, which provides deployable air defense radar and passive electronic support capabilities; and a D-AOC.[79] The DACCC mission is to prepare the DARS/DSS/D-AOC for their operational roles, enable forward-deployment of the JFAC, and conduct initial functional JFAC training for assigned JFAC personnel within AIRCOM.

So how should SACEUR execute space operations? "There are two key structural enhancements that [can] improve the coordination of multi-national forces: a liaison network and coordination centers."[80] First, NATO members should establish liaison positions in key military and civilian space organizations to foster a better understanding of missions and tactics, facilitate

[77] NATO Air Component Command website, http://www.airn.nato.int/01AboutUs/03hqstructure.html, accessed 23 November 2013.

[78] Allied Air Command overview on the NATO Website, http://www.airn.nato.int/01AboutUs/04subordi.html, accessed 15 October 2013.

[79] Ibid, http://www.nato.int/cps/en/natolive/topics_52091.htm, accessed 15 October 2013.

[80] Joint Publication 3-16, Multi-national Operations, 16 July 2013, http://www.dtic.mil/doctrine/new_pubs/jp3_16.pdf , accessed 27 September 2013.

the ability to integrate and synchronize operations, assist in the transfer of vital information, enhance mutual trust, and develop an increased level of teamwork.[81] This liaison network will be key to multi-national coordination and execution of space operations.

Second, in order to efficiently execute Allied space operations, SACEUR must designate a coordinating authority to serve as a "focal point for gathering space requirements within"[82] the theater of operations. This space coordinating authority (SCA) should have a theater-wide perspective and understand how to integrate space effects with other military capabilities in order to deconflict and prioritize requirements, as well as determine the required timing and tempo of space-derived effects. Based on two decades of U.S. space combat experience and the NATO organizational structure, SACEUR should assign SCA to the Commander, Allied Air Command (AIRCOM) at Ramstein AB, Germany.

In order to execute SCA responsibilities, the Commander, AIRCOM should establish a Space Coordination Cell (SCC) within the NATO JFAC to integrate NATO member space forces into multi-national planning and operations. The SCC should be led by a career space operations officer in the NATO grade of OF-5 who would coordinate operational objectives, commander's intent, and the desired timing and tempo of space-derived effects on behalf of AIRCOM. Member nations would retain full control of their space assets, but the SCC Director would prioritize and deconflict NATO requests for space effects, coordinate and integrate the space capabilities of NATO members, and facilitate delivery of space effects efficiently. To do so, the SCC Director and their staff would need to forge close relationships with the force providers of member nations, such as the U.S. Air Forces in Europe/U.S. Air Forces Africa Director of Space Forces (DIRSPACEFOR) at Ramstein Air Base, Germany; the U.S. Air Forces Central DIRSPACEFOR in Southwest Asia; the United Kingdom's Space Operations Coordination Centre (SpOCC) at RAF High Wycombe, UK; and others.

Finally, SACEUR and SACT should strive to increase multi-national space expertise throughout the NATO organization. There are currently just six postings within the NATO organization designated as space operations positions:

Organization	Positions	Rank
AIRCOM, Ramstein AB, Germany	A3/5 Space Planner/Staff Officer	OF-3
JFC-Brunssum, Brunssum, Netherlands	J3/5 Space Planner/Staff Officer	OF-3
JFC-Naples, Naples, Italy	J3/5 Space Planner/Staff Officer	OF-3
ACT Element-SHAPE, Mons, Belgium	Missile Defense Planner/Staff Officer	OF-3
NATO School, Oberammergau, Germany	Space Course Planner/Instructor	OF-3
JAPCC, Uedem, Germany	Space Subject Matter Expert	OF-3

[81] Ibid.

[82] Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-14 Space Operations," https://doctrine.af.mil/download.jsp?filename=3-14-D16-SPACE-OPS-SCA.pdf, accessed 5 December 2014.

Current NATO Space Operations Positions

While this is a good start, the number of space operations positions must be increased and expanded to other NATO organizations if the Alliance is to fully exploit space capabilities in the future. [83] At a minimum, SACEUR and SACT should consider adding the following 16 space operations positions:

Organization	Positions	Rank
ACT, Norfolk, Virginia	Space Staff Officer	OF-4
SHAPE, Mons, Belgium	IMS Space Plans and Policy Staff Officer	OF-4
SHAPE, Mons, Belgium	IMS Space Operations Staff Officer	OF-4
AIRCOM, Ramstein AB, Germany	Director, Space Coordination Cell (SCC)	OF-5
AIRCOM, Ramstein AB, Germany	Deputy Director, SCC	OF-4
AIRCOM, Ramstein AB, Germany	SCC Space Situational Awareness Officer	OF-3
AIRCOM, Ramstein AB, Germany	SCC Space Force Enhancement Officer	OF-3
AIRCOM, Ramstein AB, Germany	SCC Space Support Officer	OF-3
AIRCOM, Ramstein AB, Germany	SCC Space Control Officer	OF-3
MARCOM, Northwood, United Kingdom	J3/5 Space Planner/Staff Officer	OF-3
LANDCOM, Izmir, Turkey	J3/5 Space Planner/Staff Officer	OF-3
JWC, Stavanger Norway	Space Exercise Planner	OF-3
JALLC, Lisbon, Portugal	Space Lessons Learned Staff Officer	OF-3
CAOC, Torrejon, Spain	Space Planning and Integration Officer	OF-3
CAOC, Uedem, Germany	Space Planning and Integration Officer	OF-3
DACC, Poggio Renatico, Italy	Space Planning and Integration Officer	OF-3

Recommendations for New NATO Space Operations Positions

While personnel levels are constrained in the current environment, NATO leaders could consider converting 16 less important existing billets from their current roles into these new space positions. Only by permanently integrating space operations expertise across these key organizations will NATO be able to develop a coherent space operations doctrine, ensure space capabilities are fully integrated into plans and policies at all levels, and execute efficient command and control of space forces.

Training and Education

Of course, one of the obvious challenges to permanently integrating space operations expertise across key NATO organizations is developing that expertise in the first place. What common level of space related education and experience is required? Given the wide variety of duty positions across NATO, I recommend three different levels of space education and experience for given positions.

[83] NATO Space Operations Assessment, Joint Air Power Competency Center, Revised January 2009, Annex J. Annex J also listed a seventh position at Air Command, Izmir, Turkey. However, Air Command has since been consolidated at the new AIRCOM, Ramstein AB, Germany.

NATO Space Level I: Level I courses should be designed to provide a foundation of space knowledge that will aid personnel in their jobs; those personnel whose primary career field is not directly involved with the planning and application of space capabilities but who deal with space capabilities as part of their duties, such as aviation, cyberspace, communications, and intelligence personnel. Level I education will expose individuals to a variety of basic space functions and mission areas.

NATO Space Level II: Space professionals directly involved in the tactical and operational planning and application of space operations would complete Level II education. Such individuals should be knowledgeable of a variety of space systems, mission areas, and the application of space power, including how space supports joint and coalition forces. Level II education should cover space organizations; space policy, doctrine, and law; basic orbital mechanics; launch systems; the space environment; space systems; sensor fundamentals; space communications; adversary threats; and command and control structures. Personnel nominated to fill Level II coded positions should have a minimum of 3 years previous experience in the employment of space capabilities and/or dealing with space issues and should complete Level II education.

NATO Space Level III: Level III education builds on the concepts learned in Level II and would apply to space professionals in more senior operational and strategic level positions. Upon conclusion, these space professionals should understand the space-related policy and strategy environment, approaches to effectively advocate for space capabilities, and how to effectively employ space capabilities in support of national joint and coalition forces. Personnel nominated to fill Level III coded positions should have a minimum of six years previous experience in the employment of space capabilities and/or dealing with space issues and should complete Level III education.

Recommendations for NATO Space Level Position Coding

Having identified what NATO space operations personnel should receive in terms of training, education, and experience, how does NATO cultivate it? There are three potential courses of action. First, NATO could simply rely on the status quo; allow member nations to train and educate their own personnel while continuing to offer its one-week "Introduction to Space Support to NATO" course at the NATO School in Oberammergau, Germany. This option, however, would do little to improve NATO's employment of space power or provide any common level of space related education and experience.

Second, the NATO School could design and teach Level II and III space courses in addition to its Level I "Introduction to Space Support to NATO" course. This option, however, would require additional space cadre be assigned to the school, leading to additional operating costs as well as duplication of effort, which is something contrary to NATO's Smart Defence initiative. Moreover, since the NATO School is largely self-sufficient, dependent upon tuition paid by students attending its courses, this option is not likely to receive required funding.

A third potential solution is the establishment of a NATO Space Operations Center of Excellence. To date, NATO has accredited 18 Centers of Excellence (COEs) while three others are in development and pending accreditation. These "COEs are nationally or multi-nationally funded institutions that train and educate leaders and specialists from NATO member and partner countries, assist in doctrine development, identify lessons learned, improve interoperability, and

capabilities and test and validate concepts through experimentation. They offer recognized expertise and experience that is of benefit to the Alliance and support the transformation of NATO, while avoiding the duplication of assets, resources and capabilities already present within the NATO command structure."[84]

While there are currently COEs for everything from command and control to cold weather operations, a COE for space operations is conspicuously absent and should be established to provide NATO with the common training and education needed to efficiently execute multi-national space operations. Such a COE could also provide assistance to NATO in the development of space-related doctrine and could provide guest lecturers and instructors to the NATO School as required. While the Joint Air Power Competence Center (JAPCC) in Uedem, Germany currently serves as "NATO's catalyst for the improvement and transformation of Joint Air and Space Power"[85] and has written some thought-provoking documents on space, space is relegated to being part of JAPCC's Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance and Space Branch and with just one space billet, it is far from being a true space COE. As such, a dedicated space COE should be established.

Recommended space level coding for proposed NATO space positions are listed below:

Organization	Positions	Rank	Level
ACT, Norfolk, Virginia	Space Staff Officer	OF-4	III
SHAPE, Mons, Belgium	IMS Space Plans and Policy Staff Officer	OF-4	III
SHAPE, Mons, Belgium	IMS Space Operations Staff Officer	OF-4	III
AIRCOM, Ramstein AB, Germany	Director, Space Coordination Cell (SCC)	OF-5	III
AIRCOM, Ramstein AB, Germany	Deputy Director, SCC	OF-4	III
AIRCOM, Ramstein AB, Germany	SCC Space Situational Awareness Officer	OF-3	II
AIRCOM, Ramstein AB, Germany	SCC Space Force Enhancement Officer	OF-3	II
AIRCOM, Ramstein AB, Germany	SCC Space Support Officer	OF-3	II
AIRCOM, Ramstein AB, Germany	SCC Space Control Officer	OF-3	II
MARCOM, Northwood, United Kingdom	J3/5 Space Planner/Staff Officer	OF-3	II
LANDCOM, Izmir, Turkey	J3/5 Space Planner/Staff Officer	OF-3	II
JWC, Stavanger Norway	Space Exercise Planner	OF-3	II
JALLC, Lisbon, Portugal	Space Lessons Learned Staff Officer	OF-3	II

[84] NATO Centres of Excellence web page, http://www.nato.int/cps/en/natolive/topics_68372.htm, accessed 23 October 2013.

[85] Joint Air Power Competence Center mission statement, http://www.japcc.de/mission.html, accessed 18 December 2013.

Organization	Positions	Rank	Level
CAOC, Torrejon, Spain	Space Planning and Integration Officer	OF-3	II
CAOC, Uedem, Germany	Space Planning and Integration Officer	OF-3	II
DACC, Poggio Renatico, Italy	Space Planning and Integration Officer	OF-3	II
AIRCOM, Ramstein AB, Germany	A3/5 Space Planner/Staff Officer	OF-3	II
JFC-Brunssum, Brunssum, Belgium	J3/5 Space Planner/Staff Officer	OF-3	II
JFC-Naples, Naples, Italy	J3/5 Space Planner/Staff Officer	OF-3	II
ACT Element-SHAPE, Mons, Belgium	Missile Defense Planner/Staff Officer	OF-3	II
NATO School, Oberammergau, Germany	Space Course Planner/Instructor	OF-3	II
JAPCC, Uedem, Germany	Space Subject Matter Expert	OF-3	II

NATO Centers of Excellence

The United States already has its own space COE in its National Security Space Institute (NSSI) and Advanced Space Operations School (ASOpS). The NSSI's origins began with the Space Tactics School (STS) in 1994, following lessons learned in Operation DESERT STORM, specifically that campaign planning had not fully leveraged space capabilities.[86] As former U.S. Air Force Chief of Staff General John P. Jumper noted,

> We need to respect…the fact that space [has] its own culture, and that space has its own principles. …We have to also pay great attention to combining the effects of air and space because in the combining of those effects, we will leverage this technology we have that creates the asymmetrical advantage for our commanders. One way we respect those differences is by understanding we need to develop space warriors -- those trained in the planning and execution of space-based operational concepts. At the same time, these warriors are still Airmen who work in our Air and Space Operations Center, integrating space capabilities with air and surface capabilities. Air and space capabilities have to work together to bring the right war-fighting effect to the right target at the right time.[87]

STS was created to develop the space tacticians and weapon system experts General Jumper envisioned, but was absorbed into the United States Air Force Weapons School (USAFWS) in 1996.

In 2001, Air Force Space Command created a new Space Operations School (SOPSC) to teach broader space operations concepts than those taught at USAFWS. That same year, the Commission to Assess U.S. National Security Management and Organization, otherwise known as The Space Commission, delivered its report to Congress. The report amplified the need for more space education and training, noting a shortfall in developing space professionals at senior

[86] NATO Centres of Excellence web page, http://www.nato.int/cps/en/natolive/topics_68372.htm, accessed 23 October 2013.

[87] Jumper, "A Word from the Chief: Why 'Air and Space'?"

leadership levels. The Space Commission's report served as a catalyst to help transform the SOPSC into a new NSSI which activated in 2004.

NATO Accredited COEs

- Command and Control COE (C2 COE)
- Analysis and Simulation Centre for Air Operations (CASPOA)
- NATO Cooperative Cyber Defence COE (CCD COE)
- Counter-Improvised Explosive Devices COE (CIED COE)
- Civil Military Cooperation COE (CCOE)
- Combined Joint Operations from the Sea COE (CJOS COE)
- Operations for Confined and Shallow Waters COE (CSW COE)
- Cold Weather Operations COE (CWO COE)
- Defence Against Terrorism COE (COE-DAT)
- Energy Security COE (ENSEC COE)
- Explosive Ordnance Disposal COE (EOD COE)
- Human Intelligence COE (HUMINT COE)
- Joint Air Power Competence Centre (JAPCC)
- Joint Chemical Biological Radiation & Nuclear Defence COE (JCBRN COE)
- Military Engineering COE (MILENG COE)
- Military Medicine COE (MILMED COE)
- Naval Mine Warfare COE (NMW COE)
- Modeling and Simulation COE (M&S COE)

COEs in Development/Negotiation

- Military Police COE (MP COE)
- Crisis Management and Disaster Response COE (CMDR COE)

NSSI "was created … to provide space education and training to Air Force space professionals and the broader National Security Space community."[88] Originally, NSSI was comprised of a Space Professional School which provided Professional Continuing Education (PCE) and a Space Operations School which provided advanced systems training, fundamentals courses, and pre-deployment training. In 2009, the Space Professional School was realigned under Air University's Ira C. Eaker Center for Professional Development and re-designated as the NSSI while the Space Operations School remained under Air Force Space Command and was renamed the Advanced Space Operations School (ASOpS). Approximately 800 space professionals attend NSSI space professional development courses each year while the ASOpS provides a variety of space fundamentals, theater integration, and advanced mission area tactics courses.[89] Both organizations now reside within the Moorman Space Education and Training Center (SETC) on Peterson Air Force Base, Colorado. As such, it would be logical for the Moorman SETC to become a new NATO COE for space operations.

While several other NATO member nations, including Canada, the United Kingdom, France, and Germany (not to mention the NATO School itself) have some form of indigenous space operations education and training course, one could argue that none are as developed or applicable to NATO as those taught at the Moorman SETC. For example, the current NATO School course is five days of "very basic introduction on how space contributes to the warfighter"[90] while Canada's Space Operations Course (SOC), consisting of a 30-day Distance Learning package followed by 15 days of in-house instruction at the Canadian Forces School of Aerospace Studies (CFSAS) in Winnipeg, Manitoba, aims to prepare personnel with limited or no space education for employment in space-related positions.[91] The Moorman SETC, on the other hand, has a robust staff of instructors who teach nearly a dozen intermediate and advanced space operations courses.

While current security classification restrictions would prevent NATO partners from attending many of these courses, Canadian, Dutch, and Japanese personnel have attended the center's Space Operation Course[92] and other courses could likely be modified to meet NATO common security classification needs of a NATO Space Operations COE. Moorman SETC courses that are potentially applicable and valuable to NATO are listed at Appendix 3.

Eventually, a space COE of this type could grow into a formal NATO combined training and education organization similar to the Euro-NATO Joint Jet Pilot Training Program (ENJJPT) at Sheppard Air Force Base, Texas.[93] "In 1973, the rapidly rising cost of pilot training and the need to improve interoperability of NATO air forces led a group of European nations to examine the feasibility of conducting a consolidated undergraduate flying training program."[94] The

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[88] National Space Security Institute website, https://www2.peterson.af.mil/nssi/public/, accessed 23 October 2013.

[89] Ibid.

[90] Interview with Maj Newsham.

[91] National Defence and the Canadian Armed Forces web page, http://www.forces.gc.ca/en/training-establishments/international-training-programs-courses/space-operations-course.page, accessed 22 November 2013.

[92] Correspondence with DiAmco, Rudi, Maj, USAF, Advanced Courses Flight Commander, Advanced Space Operations School on 20 and 21 November 2013.

[93] The author attributes this thought to Major Lars Wilhelmy, German Air Force liaison to the German Space Agency as discussed in a sidebar conversation at the NATO School.

[94] Euro-NATO Joint Jet Pilot Training Program Fact Sheet, http://www.sheppard.af.mil/library/factsheetspage/factsheet.asp?fsID=5168, accessed 18 December 2013.

program officially opened in October, 1981 and today is "the world's only multi-nationally manned and managed flying training program chartered to produce combat pilots for NATO."[95] Officers from all 13 participating nations fill leadership positions throughout the wing and five nations "provide instructor pilots based on their number of student pilots."[96] "The benefits of the ENJJPT Program are many – lower cost, better training environment, enhanced standardization and interoperability," not to mention that the student pilots and staff instructors training together today will be the leaders of NATO's air forces of tomorrow. Space could benefit greatly from the same sort of training construct.[97]

Organizational and Operational Challenges

As noted above, one of the key challenges to instituting a new NATO COE – and executing multi-national space operations in general – is security classification and data sharing. The release of classified information to multi-national partners is governed by the national disclosure policies of each NATO member. In order to effectively execute Allied space operations, the Alliance would need to share missile warning, space situational awareness, and other space related data. This is already being done to some level with ballistic missile warning data via the Shared Early Warning System (SEWS) program through which the U.S. Air Force "provides NATO with a continuous enhanced Space-based early warning data feed…in support of the [ballistic missile defense] mission. [Through SEWS,] NATO receives data from space-based sensors with the same accuracy and timeliness as US forces."[98]

Moreover, NATO is working on a Coalition Shared Data (CSD) server project that will "allow commanders to instantly tap into real-time data from a number of NATO and national systems…regardless of where those products are stored."[99] The concept was successfully tested during NATO's BOLD AVENGER/TRIAL QUEST 2007 as well as German Bundeswehr experiment Common Shield 2008 and could be extrapolated for use in a broader NATO space data sharing enterprise.

A second challenge is ensuring member nation systems have some minimum level of interoperability. NATO does already have a multitude of Standardization Agreements (STANAGs), some of which address space related systems and components such as STANAG 4636: Space and Nuclear Hardening Guidelines for Military Satellites, STANAG 4633: NATO Common ELINT Reporting Format, and STANAG 7023: NATO Primary Image Format. However, in light of the Smart Defence initiative which "encourages nations to get the most capability from their defense spending by focusing on greater prioritization, specialization and multinational cooperation in equipment acquisition,"[100] NATO should take a fresh look at the spectrum of space systems and determine if new STANAGs should be developed.

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[95] Ibid.
[96] Ibid.
[97] Ibid.
[98] Al Burke, "Air Force Space Command Supports NATO Ballistic Missile Defense Declaration at NATO Summit," http://www.afspc.af.mil/news/story.asp?id=123306388, accessed 30 October 2013.
[99] Barbara Essendorfer and Willmuth Mueller, "Interoperable Sharing of Data With the Coalition Shared Data (CSD) Server," p. 1, http://ftp.rta.nato.int/public/pubfulltext/rto/mp/rto-mp-ist-086/mp-ist-086-07.pdf, accessed 30 October 2013.
[100] Julian Hale, "7 NATO Countries To Join U.S. in Schriever Wargame," *Defense News*, http://www.defensenews.com/print/article/20120418/DEFREG02/304180009/7-NATO-Countries-Join-U-S-

Third, in our current scarce economic times, it may be difficult for member nations to fund a new COE and man 16 new space operations positions. Doing so, however, will be critical to the success of NATO's Connected Forces Initiative (CFI) as one of the key components of the initiative is expanded education and training. Specifically, CFI requires Alliance members to "capitalize collectively on the individual training efforts of Allies and identify areas for collaboration and potential synergies…so that Allies can come together and be ready for any eventuality."[101]

Exercises

With the upcoming end of the International Security Assistance Force's (ISAF) mission in Afghanistan, NATO is expected to shift its emphasis from operational engagement to operational preparedness through its CFI. CFI is intended to build on the Alliance's recent experience in Afghanistan and ensure the Allies can work even more effectively together in the future.[102] A key pillar of this initiative is increased exercises as "an essential means for forces to practice tactics, techniques and procedures, promote and gauge interoperability, validate training and, when required, certify headquarters, units and formations."[103]

In order to ensure the Alliance is able to fully exploit space capabilities, space operations should be incorporated into a variety of tactical, operational, and strategic level exercises and war games. At the tactical level, this could include such things as a multi-national RED FLAG exercise. RED FLAG is a realistic combat training exercise involving the air forces of the United States and its allies. Conducted on the vast bombing and gunnery ranges of the Nevada Test and Training Range, RED FLAG was established in 1975 to maximize the combat readiness, capability and survivability of participating units by providing realistic training in a combined air, ground, space and electronic threat environment as well as a free exchange of ideas between forces.[104] Participating units execute missions against an opposing "Aggressor" force specially trained to replicate the tactics and techniques of potential adversaries. While Red Flag originally developed a flyer's combat proficiency, the last eight years have slowly incorporated space and cyberspace capabilities.[105] Previously segregated from the CAF participants, space and cyber operators are now fully integrated at the tactical level as a primary training audience.

At the operational level, NATO could participate in a BLUE FLAG exercise. BLUE FLAG is an U.S. Air Force "Air Combat Command-sponsored exercise program that provides doctrinally-correct air, space, and cyberspace crisis action planning (CAP) and command and control (C2) training for joint/coalition air components and operational-level headquarters at the operational level of war."[106] Just as RED FLAG is intended to increase the combat survivability

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Schriever-Wargame, accessed 25 October 2013.

[101] NATO Connected Forces Initiative web page, http://www.nato.int/cps/en/natolive/topics_98527.htm, accessed 25 October 2013.

[102] Ibid.

[103] Ibid.

[104] RED FLAG Fact Sheet, http://www.nellis.af.mil/library/factsheets/factsheet.asp?id=19160, accessed 25 October 2013.

[105] Maj, Chris Roszak, USAF, "Red Flag space operations: Not just a flyer's exercise," http://www.afspc.af.mil/news/story.asp?id=123252927, accessed 25 October 2013.

[106] BLUE FLAG Fact Sheet, http://www.505ccw.acc.af.mil/library/factsheets/factsheet.asp?id=15317, accessed 25

of tactical forces, the goal of BLUE FLAG is to train commanders and staff officers at the operational level of war so "they can immediately participate in directing an air war and make smart decisions during the critical first days of an engagement."[107]

Alternatively, NATO could integrate space operations into existing operational level exercises such as 2007's Exercise COOPERATIVE ARCHER; 2009's Exercise BOLD AVENGER; 2011's Exercise ALLIED REACH; or the STEADFAST series of exercises. The Steadfast series of exercises are part of NATO's efforts to maintain a connected and interoperable multi-national NATO Response Force able to respond to the full-spectrum of potential missions.[108] "To date, 17 exercises have been held in the series, with elements hosted in 14 different countries."[109] NATO introduced space operations in STEADFAST JAZZ 13, although at an extremely limited level.[110] Moreover, since space wasn't a Major Training Objective of the exercise, it received little focus or interest from senior NATO leaders.[111] This level of effort should be greatly increased in future exercises.

Finally, at the strategic level, NATO should continue participating in the Schriever war games. As previously noted, eight NATO countries (Denmark, France, Germany, Greece, Italy, the Netherlands, Turkey, and the United States) took part in Schriever Wargame 2012 along with international partners from Australia, Canada and the United Kingdom. The war game explored critical space issues and investigated the integration activities of multiple agencies associated with space systems and services, producing several lessons learned for the Alliance.

Conclusion

Space capabilities are proven force multipliers. The ability of NATO to exploit space capabilities during a conflict and prevent adversaries from doing the same is critical to the success of military operations. Lessons learned over the past 25 years point to the urgent need for NATO to develop an operational framework that enables SACEUR and his subordinate commanders to exploit and synchronize available Alliance space assets. This includes drafting a space operations doctrine; establishing a well defined space command and control structure; developing processes and procedures for requesting and integrating member nation space capabilities into NATO operations; cultivating space expertise in the right positions at the right organizations across NATO; and incorporating space into all future NATO exercises and war games.

Space forces are critical to fighting and winning modern warfare and employment of space capabilities requires special doctrinal focus. While NATO does address space operations to some level in various documents, the current level of emphasis is insufficient and a more comprehensive NATO space doctrine document should be developed.

In addition, space expertise must be permanently established throughout NATO at the right level in the right organizations in order to fully understand what space capabilities are

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October 2013.

[107] Ibid.

[108] "Scope, Aim, Components, Conduct, Locations," http://www.nato.int/nato_static/assets/pdf/pdf_2013_10/20131031_131031-SFJZ13-Factsheet.pdf, accessed 10 December 2014.

[109] NATO STEADFAST JAZZ web page, http://www.aco.nato.int/participants.aspx, accessed 25 October 2013.

[110] NATO Bi-Strategic Command Space Working Group Progress Report, 23 May 2013, para 15, http://www.act.nato.int/images/stories/events/2012/nato_space/progress_report.pdf, accessed 16 November 2013.

[111] Unnamed source directly involved with the STEADFAST JAZZ exercise.

available, how to exploit those capabilities, and to provide command and control of Allied space operations. A critical component of this requirement is for SACEUR to assign SCA to the Commander, AIRCOM and for AIRCOM to establish a SCC within the NATO JFAC to integrate NATO member space forces into multi-national planning and operations.

In order to cultivate the required space expertise, NATO should advocate that a new Space COE be established and accredited. The United States already has its own space COE in its Moorman SETC, which is comprised of the NSSI and the ASOpS. Approximately 800 space professionals attend NSSI space professional development courses each year while the ASOpS provides a variety of space fundamentals, theater integration, and advanced mission area tactics courses.[112] While current security classification restrictions would prevent many NATO partners from attending these courses, they could be modified to meet NATO common security classification needs.

Finally, NATO should participate and incorporate space as Major Training Objectives into a variety of tactical, operational, and strategic level exercises and wargames such as RED FLAG, BLUE FLAG, and STEADFAST JAZZ as "an essential means for forces to practice tactics, techniques and procedures, promote and gauge interoperability,"[113] and ensure the Alliance is able to effectively command and control space forces.

A variety of challenges lie ahead, including the need to overcome security classification and data sharing hurdles, interoperability requirements, funding, and manning. However daunting these challenges may be, NATO must address and overcome them in order to succeed in future conflicts. Given the level of interest among key NATO leaders and the recent establishment of a Bi-Strategic Command Space Working Group, the time is right to strike while commitment is high; delaying could lead to catastrophic effect.

[112] National Space Security Institute website, https://www2.peterson.af.mil/nssi/public/, accessed 23 October 2013.

[113] NATO Connected Forces Initiative web page, http://www.nato.int/cps/en/natolive/topics_98527.htm, accessed 25 October 2013.

Appendix 1: Key NATO Member Military/Government Space Capabilities[114]

Mission Area	Country	Asset	Function/Capabilties
Space Situational Awareness	France	GRAVES	Bistatic VHF radar used for military operations by the French Air Force. Provides ground-based space surveillance.
	USA	Advanced Research Project Agency Long-Range Tracking and Instrumentation Radar (ALTAIR)	Provides high-sensitivity, wide-bandwidth, coherent, radar satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FPQ-16 Perimeter Acquisition Radar Characterization System (PARCS)	Provides radar space space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FPS-85 Phased Array Space Surveillance Radar	Provides radar space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FPS-108 COBRA DANE radar	Provides radar space space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FPS-123 Pave Phased Array Warning System (PAVE PAWS) early warning radars	Provides radar space space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FPS-132 Upgraded Early Warning Radars (UEWR)	Provides radar space space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA	AN/FSQ-114 Ground-Based Electro-Optical Deep Space Surveillance System (GEODSS)	Provides electro-optical space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.

Mission Area	Country	Asset	Function/Capabilties
	USA	Space Based Space Surveillance (SBSS) system	Provides visible space space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	Canada	Sapphire Space Surveillance Satellite	Provides electro-optical space surveillance on orbiting objects within its area of coverage.
Space Force Enhancement	France, Italy, and Spain	Helios	Provides high-resolution space-based optical reconnaissance.
	Germany	SAR Lupe	Provides space-based Synthetic Aperture Radar reconnaissance.

[114] In order to keep this paper unclassified, all data in the body of the text and the appendices was obtained from open source material, including the Jane's Defence Space Systems and Industry website, Air Force Space Command fact sheets, 21st Space Wing fact sheets, and a variety of company web pages.

	USA	AN/FPQ-16 Perimeter Acquisition Radar Characterization System (PARCS)	Provides early warning, launch and predicted impact data on ballistic missiles within its area of coverage.
	USA	AN/FPS-108 COBRA DANE radar	Provides early warning, launch and predicted impact data on ballistic missiles within its area of coverage.
	USA	AN/FPS-123 Pave Phased Array Warning System (PAVE PAWS) early warning radars	Provide early warning, launch and predicted impact data on ballistic missiles within its area of coverage.
	USA and United Kingdom	AN/FPS-129 Upgraded Early Warning Radars (UEWR)	Provides radar space surveillance, satellite tracking, and space object identification data on orbiting objects within its area of coverage.
	USA and United Kingdom	AN/FPS-132 Upgraded Early Warning Radars (UEWR)	Provide early warning, launch and predicted impact data on ballistic missiles within its area of coverage.
	USA	Advanced Extremely High Frequency (AEHF) System satellites	Provides survivable, global, secure, protected, and jam-resistant communications for high-priority military ground, sea, and air assets
	USA	Defense Meteorological Satellite Program (DMSP) satellites	Provides continuous visual and infrared imagery of cloud cover as well as moisture and temperature profiles with global coverage of weather features accomplished every 14 hours.
		Defense Satellite Communications System (DSCS) satellites	Provides nuclear-hardened, anti-jam, high data rate, long haul communications to users worldwide.

Mission Area	**Country**	**Asset**	**Function/Capabilties**
	USA	Defense Support Program (DSP) early warning satellites	Provides infrared detection of missile launches, space launches, and nuclear detonations word-wide.
	USA	Global Positioning System (GPS) satellites	Provides precise position, navigation, and timing information to users worldwide.
	USA	Milstar communications satellites	Provides the President, Secretary of Defense and the U.S. Armed Forces with assured, survivable satellite communications (SATCOM) with low probability of interception and detection
	USA	Space Based Infrared System (SBIRS)	Provides infrared support to missile warning, missile defense, battlespace awareness, and technical intelligence missions.
	USA	Wideband Global SATCOM Satellite	Provides worldwide flexible, high data rate and long haul communications for marines, soldiers, sailors, airmen, the White House Communication Agency, the US State Department, international partners, and other special users.

Space Support	USA	Eastern Range, Patrick AFB and Cape Canaveral AFS, Florida	Pro-grade, geosynchronous, and geostationary launch capabilities.
	USA	Ronald Reagan Ballistic Missile Test Site, US Army Kwajalein Atoll, Marshall Islands	Missile testing and orbital launch capabilities.
	USA	Western Range, Vandenberg AFB, California	Polar and sun-synchronous orbit launch capabilities.
	USA	FALCON launch vehicle	Low cost capability to orbit small spacecraft.
Counter-Space	USA	Rapid Attack Identification, Detection, and Reporting System (RAIDRS)	Detects, characterizes, geolocates, and reports sources of radio frequency interference on U.S. military and commercial satellites in direct support of combatant commanders.
	USA	Counter-Communications System (CCS)	Rapidly achieves flexible and versatile effects in support of global and theater campaigns.

Mission Area	Country	Asset	Function/Capabilties
Command and Control	Germany	German Space Situational Awareness Centre	Provides an integrated space situational awareness picture including a space object catalog; overflight/collision/re-entry/space weather warning; GPS precision forecasts; and SATCOM bandwidth forecasts and warnings.
	USA	Joint Space Operations Center (JSpOC)	Provides synergistic command and control capabilities for the operational employment of worldwide joint space forces.
	USA	Distributed Space Command and Control-Dahlgren (DSC2-D)	Provides backup synergistic command and control capabilities for the operational employment of worldwide joint space forces.

Appendix 2: Key NATO Member Civil/Commercial Space Capabilities

Mission Area	Country	Asset	Function/Capabilties
Space Situational Awareness	European Space Agency	Optical Ground Station (La Teide, Tenerife Observatory)	Provides ground-based electro-optical space surveillance. Built by ESA for tests with laser link and space debris observations, it is now used for astronomy observations.
	Germany	Tracking and Imaging Radar (TIRA)	34 meter parabolic dish with a L-band tracking radar and a Ku-band imaging radar. Provides ground-based radar tracking and imaging of satellites in its field of view.
	Italy	Croce del Nord	Very large array astronomical telescope that is being used experimentally for LEO debris observations.
	Spain	OLS	A set of three telescopes at the La Sagra Observatory which are primarily used for NEO observations, but are also being used for GEO and MEO surveillance activities.
	United Kingdom	Chibolton CAMRa	25 meter steerable dish radar being used as part of the SSA programme. Provides ground-based radar tracking and imaging of satellites in its field of view.
	Spain	The Fabra-ROA telescope at Montsec (TFRM)	A refurbished Baker-Nunn telescope designed specifically for GEO, MEO and LEO surveillance activities.
	Spain	OGS	1 meter tracking telescopes used to refine GEO obits and detect very faint debris in the GEO/MEO regimes.
	United Kingdom	Starbrook	The Starbook telescopes are owned and operated by Space Insight Limited, a private UK company. The telescopes are used on a regular basis to perform surveys of the GEO and MEO regions.
Space Force Enhancement	Canada	Anik F and G series communications satellites	Provides C and Ku-band communications across North and South America.
	Canada	Telstar series communications satellites	Provides C and Ku-band communications across North and South America, Europe, Africa, and the Middle East.
	European Consortium	Advanced Relay and Technology Mission Satellite (ARTEMIS)	Provides laser-based inter-satellite data relay and mobile L/S/Ka-band communications services over Europe.
	European Consortium	Astra series communications satellites	Provides Ku-band communications across Western Europe, Eastern Europe, the Baltics, the Nordic countries, Ukraine, and Russia.

	European Consortium	EUTELSAT series communications satellites (to include SESAT and HOTBIRD satellites)	Provides C and Ku-band communications across the Americas, Europe, Africa, the Middle East, and Asia.
	European Consortium	KA-SAT communications satellite	Provides Ka-band communications across Europe, North Africa, and the Middle East.
	European Consortium	SES series communications satellites	Provides C and Ku-band communications across the Americas, Europe, North Africa, and the Middle East.
	European Union	Copernicus	A complex set of systems which collect data from multiple sources earth observation satellites, ground stations, airborne and sea-borne sensors to provide data on land, marine, atmosphere, climate change, emergency management, and security.
	European Space Agency	METEOSAT satellites	Provides atmospheric observation and meteorological forecasting data.
	France	Satellite Pour l'Observation de la Terre (SPOT) satellites	Provides high resolution space-based optical imaging.

Mission Area	**Country**	**Asset**	**Function/Capabilties**
	France and USA	JASON satellites	Provides high-resolution data on ocean currents and their variations, as well as sea surface height measurements.
	Germany	TerraSAR-X	Provides high-resolution SAR imagery with a resolution down to 25cm independent of weather conditions and illumination.
	Germany	TanDEM-X	Provides high-resolution SAR imagery with a resolution down to 25cm independent of weather conditions and illumination. In tandem with TerraSAR-X, forms a high-precision radar interferometer in space able to produce high-resolution 3-D images.
	Spanish and Brazilian Consortium	Amazonas communications satellites	Provides C and Ku-band communications across the Americas, Europe, and North Africa.
	Spain	Hispasat series communications satellites	Provides Ku-band communications across North America and Europe.
	USA	EchoStar series communications satellites	Provides Ku-band communications across the United States, Hawaii, Alaska, Canada, and Puerto Rico.
	USA	Galaxy series communications satellites	Provides C and Ku-band communications across North and South America, the Caribbean, and Asia
	USA	Globalstar communications satellites	Provides C/S-band communications over 80% of the Earth's surface.

	USA	Intelsat series communications satellites	Provides C and Ku-band communications across 99% of the world's populated areas.
	USA	Iridium series communications satellites	Provides global voice, fax and data global handheld services.
	USA	Landsat	Provides space-based imagery with 15-60 meter resolution in multiple spectral bands.
	USA	Leasat/Syncom IV series communications satellites	Provides UHF communications world-wide.
	USA	Orbcomm series communications satellites	Provides VHF and UHF communications world-wide.

Mission Area	**Country**	**Asset**	**Function/Capabilties**
	USA	TerreStar series communications satellites	Provides S-band voice, data and video services directly to mobile devices and vehicles in N. America, Hawaii and Puerto Rico
Space Support	ESA	Vega launch vehicle	Designed to carry single or multiple payloads weighing 300 to 2,500 kg into low Earth orbit (LEO) (700 km).
	European and Russian Consortium	Rockot launch vehicle	Small-medium payloads (up to about 1,900 kg) into intermediate polar or sun-synchronous orbits
	France	Centre Spatial Guyanais, Kourou, French Guyana	Pro-grade, geosynchronous, geostationary, polar, and sun-synchronous launch capabilities
	Italy	San Marco Launch Platform, Kenya	Sub-orbital and Low Earth Orbit launch capabilities
	Norway	Andøya Rocket Range, Norway	Sub-orbital and small polar launch capabilities
	Norway	Tromsø Satellite Station, Norway	Polar satellite receiving station.
	USA	Antares (Taurus II) launch vehicle	Delivery of medium-class (5,000-6,000 kg) payloads to a variety of low inclination Low Earth and sun-synchronous orbits.
	USA	Athena launch vehicle	Delivery of 700 kg to 200 km Low Earth Orbit or 400 kg to 200 km Sun Synchronous Orbit
	USA	Atlas V	Heavy and medium class U.S. military, communications, scientific, and meteorological satellites into Geosynchronous Transfer Orbit.
	USA	Delta IV launch vehicle	Medium/Heavy (4,000-22,000 kg) launch capabilities.
	USA	Evolved Expendable Launch Vehicle	Medium/Heavy (4,000-22,000 kg) launch capabilities.
	USA	Falcon series (SpaceX) launch vehicle	Designed to deliver a 420 kg payload into Low Earth Orbit.
	USA	Minotaur launch vehicle	Delivery of small payloads to Low Earth Orbit.
	USA	Pegasus launch vehicle	Air-launched delivery of small payloads to Low Earth Orbit

	USA	Taurus launch vehicle	Delivery of medium-class payloads to Low Earth Orbits.
	USA	Kennedy Space Center, Florida	Manned spaceflight launch capabilities.
	USA	Kodiak Launch Complex, Alaska	Sub-orbital and small Low Earth Orbit launch capabilities

Mission Area	**Country**	**Asset**	**Function/Capabilties**
	USA	Poker Flat Research Range, Alaska	Sub-orbital launch capabilities
	USA	Wallops Flight Facility, Virginia	Sub-orbital and Low Earth Orbit launch capabilities.

Counter-Space	None	None	None
Command and Control	European Space Agency	European Space Operations Centre	Conducts mission operations for ESA satellites and to establish, operate and maintain the necessary ground-segment infrastructure.
	European Union	European Union Satellite Center	Provides products resulting from the analysis of satellite imagery and collateral data, and related services in support of the Common Foreign and Security Policy, including European Union crisis management operations.

Appendix 3: Moorman Space Application and Training Center Courses Potentially Applicable or Valuable to NATO

Course[115]	Objectives	Length	Notes
NSSI Space 200	NSSI's mid-career course for space professional education. The course investigates two major areas: Space Systems Development and Space Power. The course looks at space acquisition policies and space mission design principles; analyzes the impact of space mission areas in support of joint and coalition forces; and analyzes the impact of competing capabilities on joint and coalition forces.	18 days	Offered by invitation only.
NSSI Space 300	NSSI's capstone course for space professional education. It develops space professionals who understand national policy considerations and strategic thought within an international geopolitical environment. The course analyzes the space acquisition environment to develop an understanding of its impact on the delivery of space capabilities and national security; the space-related policy and strategy environment; approaches to effectively advocate for space capabilities; and approaches to effectively employ space capabilities in support of national leadership and joint/coalition forces.	15 days	Offered by invitation only.
ASOpS Space Operations Course (SOC)	A familiarization course for all branches of service, military and civilian. Provides an educational and training bridge for new space support personnel or those within operations with little space exposure. The course develops a fundamental understanding of capabilities, limitations and vulnerabilities of space systems; enhances understanding of basic space systems; provides a fundamental knowledge of doctrine, space law, orbital dynamics, environment, and physics of space systems; and enables understanding of the application of space systems in a military environment.	2 weeks	Attendees require a current Secret clearance.
ASOpS Space Operations Executive Level Course (SOC-E)	Designed for senior-ranking individuals new to the space operations career field or those simply requiring a refresher course in the capabilities, limitations and vulnerabilities of critical DoD, national, civil and commercial space systems. The course focuses on the needs of senior military commanders and provides a more complete understanding of the capabilities, limitations and vulnerabilities of critical DoD, national, civil, and commercial space systems.	2 days	Attendees require a current Top Secret-Sensitive Compartmented Information clearance.

[115] Course information obtained from the National Space Security Institute website, https://www2.peterson.af.mil/nssi/public/, accessed 23 October 2013 and Advanced Space Operations School website, https://www2.peterson.af.mil/nssi/CESET/asops/index.htm, accessed 23 October 2013.

Course	Objectives	Length	Notes
ASOpS Director of Space Forces (DIRSPACEFOR) Course	Designed to provide selected senior leaders education and training in preparation to serve as the senior space advisor to the COMAFFOR or JFACC. Emphasis is placed on AOC operations and the role the DIRSPACEFOR plays in integrating space into theater operations and advising the JFACC on Space Coordinating Authority role.	5 days	Attendees require a current Top Secret-Sensitive Compartmented Information clearance.
ASOpS Advanced Orbital Mechanics (AOM) Course	Develops space professionals who can create innovative TTPs by applying the principles of advanced orbital mechanics to determine orbits, identify launch windows, execute on-orbit maneuvers, and effectively plan and execute orbital rendezvous and proximity operations.	3 weeks	Attendees require a current Secret clearance.
ASOpS Missile Warning and Defense Advanced Course (MWDAC)	Designed to provide in-depth Missile Warning and Defense (MWD) knowledge to enhance system expertise in order to constructively influence MWD development, acquisition, employment, and sustainment, and develop innovative system TTPs. The course of instruction includes: space fundamentals, infrared and radar physics and processing, MWD systems capabilities and limitations, MWD architectures, command and control, law and policy, doctrine, strategy and tactics, rules of engagement, acquisition strategy, related software applications, and case studies.	4 weeks	Attendees require a current Top Secret-Sensitive Compartmented Information clearance.
ASOpS Navigation Operations Advanced Course (NAVOPS AC)	Designed to provide in-depth knowledge of the Global Positioning System (GPS), Navigation Operations, and Navigation Warfare (NAVWAR). Students will obtain knowledge and develop skills in the application of advanced NAVWAR concepts to theater operations. Heavy emphasis is placed on GPS signals and codes, GPS users, GPS integration, electronic warfare, jamming, and NAVWAR concepts, Tactics, Techniques, and Procedures (TTP), capabilities, applications, threats and countermeasures.	15 days	Attendees require a current Secret clearance.
ASOpS Satellite Communications Advanced Course (SATCOMAC)	Designed to provide in-depth SATCOM expertise to space professionals in efforts to enhance their system knowledge to constructively influence SATCOM development, acquisition, employment and sustainment and craft innovative TTPs. This course covers topics such as SATCOM systems application, employment, and warfighter-related capabilities, limitations, vulnerabilities (CLVs) and effects through analysis of technical system components, including the ground, space and control segments.	3 weeks	Attendees require a current Secret clearance.

About the Author

Colonel Paul A. Tombarge holds a Bachelor of Arts degree in Political Science from the University of Minnesota, a Master of Arts degree in Public Administration from the University of Maryland-Europe, a Master of Arts degree in International Security Studies from the Naval Postgraduate School, and a Graduate Certificate in Space Systems from the Naval Postgraduate School. He was also a U.S. Senior Fellow at the George C. Marshall European Center for Security Studies from 2013-2014. Colonel Tombarge's areas of expertise include missile warning, missile defense, space surveillance, space control, and Joint Special Technical Operations. He also has experience in political-military security cooperation activities.

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