

The Increasing Importance of the Space Domain in Strengthening NATO's Deterrence Posture

Donald A. Lewis

The Aerospace Corporation
P.O. Box 92957
Los Angeles, California 90009
UNITED STATES

donald.a.lewis@aero.org

ABSTRACT

NATO has depended upon the space domain to support its deterrence objective for decades. Although perhaps often overlooked or underestimated, NATO's asymmetric military advantages enhanced by space have contributed a major element to the Alliance's overall deterrence posture. As space becomes officially recognized within the Alliance as a domain of operations (like cyber), it will become increasingly important to both leverage its contribution to NATO's net deterrence posture as well as manage critical perceptions of its strengths and vulnerabilities to maximize its value to deterrence. Space provides enhancement of force strength through space-based intelligence, surveillance and reconnaissance; enabling command and control via satellite communications; providing position, navigation and timing services via satellite navigation systems; and global weather insights from meteorological satellites. Space also enables information dominance in the battle space, a likely key element of future conflict throughout all domains. All of which are important contributions to NATO's net deterrence strength. However, space is increasingly a contested, congested and competitive environment and the Alliance's space capabilities must be protected against environmental and adversarial degradation or denial to ensure their continued deterrence value. Managing deterrence messaging relative to the space domain must consider both the strengths that space brings to the Alliance as well as the strengths that the domain may bring to its potential adversaries. Failure to consider the implications of adversary perceptions of space as an operational domain within NATO's deterrence calculus may precipitate escalation in adversary advanced space capabilities including counterspace capabilities intended to mitigate against the critical value NATO derives from the space domain.

1.0 INTRODUCTION

NATO has depended upon the space domain to support its deterrence objective for decades. When space services were first made available to NATO in the 1970's, NATO's asymmetric military advantages were greatly enhanced. Those advantages, as perceived at the time by the former Soviet Union, contributed a major element to the Alliance's overall deterrence posture. Today the space domain is integrated into all NATO operational constructs and is essential to all NATO core mission areas, including deterring adversary aggression.

Although the space domain (which will be defined shortly) has contributed to NATO's deterrence strength, that contribution has been largely unrecognized by many for many decades. There are various reasons for this including the simple fact that, for the most part, the fight has never been taken into space. Space is often treated as a utility providing "services" rather than a location where combat operations take place putting human or capital resources at risk. Communications, navigation, timing, reconnaissance, missile warning and weather services have been faithfully provided to the Alliance by a few of its space-faring member nations, often with little comprehensive understanding by NATO forces of where such services really come from or how to effectively employ all the available capabilities.

The role of space in defense was long considered something of a utility; important, sometime critical, but not necessarily central to winning the fight. Appreciation of the role that the space domain plays in supporting the security of both Alliance nations individually and NATO as a whole probably became most apparent during the first Gulf War¹. Space was then recognized as having enabled a theretofore unprecedented large scale joint operation across the land, maritime and air domains². Some have even called that the first “space war”³ although there were no combat operations in space. However, a “service provider” view of space persisted for another decade or so. But now circumstances prevail that are rapidly changing the global perspective on the space domain and the substantially greater contribution it will make to future global security operations. Despite the recognized value of space, incorporation and integration of space services throughout many NATO members’ militaries and defense enterprises has been slow and inconsistent. Thus, there is an imperative to increase the integration of the space domain into NATO paradigms and capabilities to enhance its net deterrence.

Several factors contribute to the view that “space” is a domain of operations in its own right; although with limited consensus among many on the relative importance of those factors. One of the more impactful events contributing to Western acknowledgement of the importance of space was the 2007 Chinese anti-satellite test⁴ against one of their own spacecraft. Much has been written on the importance of that event, but suffice to say that it sent an implicit message that at least one potential adversary thought the military value of space was sufficiently important that it had become necessary to develop the means to deny that capability to its enemies. That event precipitated the global realization that space had become a contested, congested and competitive domain, even in the context of NATO’s space equities.⁵

In addition to the development and demonstration of counterspace capabilities, the proliferation to potential NATO adversaries of increasingly advanced space capabilities enabling advanced warfare concepts including hybrid warfare is also now a concern. For example, increasingly capable and persistent space-based reconnaissance capabilities (including those of the international commercial sector^{6,7}) coupled with commercial sector-driven advanced data analytics enable heretofore unprecedented abilities to detect, assess and track global activities for purposes inimical to NATO. Furthermore, the projected launches of “mega” constellations⁸ of literally many hundreds of small communication satellites offers the potential of global data connectivity (access) unencumbered by terrestrial infrastructure; a boon for special operations and non-state adversaries alike.

One of several factors slowing the acknowledgement of space as an operational domain within the Alliance is the high cost of building, launching and operating spacecraft. Until recently some NATO members were loath to address their dependency on space because of the perceived potential for very costly commitments

[1] The 1991 Gulf War was not a NATO action but was most certainly analyzed by many for the impact of the application of advanced military capabilities including space.

[2] Including the extensive use of GPS-enabled precision guided munitions that visibly underscored overwhelming military might.

[3] www.scientificamerican.com/article/gps-and-the-world-s-first-space-war/ 8 February 2016; Accessed 18 October 2018

[4] www.en.wikipedia.org/wiki/2007_Chinese_anti-satellite_missile_test Accessed 18 October 2018

[5] Schulte, Gregory L., Protecting NATO’s Advantage in Space, Transatlantic Current, National Defense University Institute for National Strategic Studies, May 2012

[6] www.spacenews.com/with-six-new-satellites-and-more-coming-planet-looks-to-disrupt-high-res-imagery-market/ Accessed 30 October 2018

[7] www.spacenews.com/u-s-wargame-highlights-role-of-commercial-space-imagery-in-military-conflicts/ Accessed 30 October 2018

[8] www.spacenews.com/divining-what-the-stars-hold-in-store-for-broadband-megaconstellations/ Accessed 30 October 2018

required to provide capability to the Alliance. But, perhaps because of perceived vulnerabilities due to the Russian invasion of Ukraine in 2014, NATO has since substantively evolved its perspectives and posture on space.

Following the July 2018 NATO Brussels Summit, the participating Heads of State and Government acknowledged in their Summit Declaration two specific perspectives relevant to their evolving posture on space:⁹

“We have agreed to strengthen the Alliance’s deterrence and defence posture in all domains.”

“... space is a highly dynamic and rapidly evolving area, which is essential to a coherent Alliance deterrence and defence posture, we have agreed to develop an overarching NATO Space Policy.”

Development of a NATO space policy is now underway and will further precipitate dialog on the role of space as a critical element of Alliance for deterrence. An anticipated outcome of the space policy deliberations will be the eventual need for official endorsement of space as a domain of operations; much like the treatment of cyber as a domain.¹⁰ In 2016 the Alliance officially declared cyber a domain of operations allowing for training and military planning purposefully focused on cyber. A similar result may be anticipated for the space domain.

The terrestrial, maritime and air operational environments have long been recognized as operational “domains” and have served as means for achieving economies of scale and strength within the Alliance. Alignment of common strategies and tactics with respect to those domains along with materiel capabilities among the member nations contributes to the net implied (and messaged) strength of NATO. And now, as noted, cyber is also recognized as a domain critical to the strength of the Alliance with space soon to follow.

The space domain can be usefully characterized in a manner analogous to the maritime domain. The maritime domain, as defined by the U.S. White House in 2004, is defined as “all areas and things of, on, under, relating to, or bordering on a sea, ocean, ... including all maritime-related activities, infrastructure, people, cargo, and vessels and other conveyances.”¹¹

Thus, if we consider “outer space” to be that region 100 km beyond the Earth’s surface¹², the space domain can be then usefully defined as *all conditions, areas, activities and things in and terrestrially relating to outer space, including space-related activities, missions, infrastructure, people, cargo, means of communication and spacecraft and other conveyances to, in, through and from outer space and the Earth*. This definition implicitly acknowledges the importance of the supportive activities and threats related to land, maritime, air and cyber regimes affecting space domain operations as well as the spectrum of elements that comprise the domain; implying the potential strength of cross-domain deterrence.

The intent of this paper is to put forth and explore some of the issue threads that NATO should consider as it evolves its new space policy construct to contribute to its deterrence posture in the years to come. The mainstream of NATO deterrence theory and practice is anticipated to continue to evolve with the changing threat environment and hopefully effective incorporation of the space domain into that calculus will contribute to the net deterrence.

[9] NATO Brussels Summit Declaration, PR/CP(2018)074, 11 July 2018

[10] www.nato.int/cps/en/natohq/topics_78170.htm Accessed 18 October 2018

[11] Maritime Security Policy: National Security Presidential Directives NSPD-41 and Homeland Security Presidential Directive HSPD-13; 21 December 2004

[12] There is no hard-scientific definition of how high one must go to reach “outer space.” International convention uses the region beyond the Kármán line, an altitude of 100 km (62 mi) above sea level, as the basis for “outer space” as defined in space treaties, etc.

This paper is not focused on any particular potential adversary of the Alliance nor the application of deterrence theory to their specific equities and behaviors, but rather on the generalized nature of space as a domain of operations that offers both threats, risks and opportunities that should not be overlooked.

Deterrence is largely about perception and its management in the mind of one's adversaries or opposing forces. Strategic shaping of perceptions requires consistent messaging over time, while tactical deterrence must be managed in moments of crisis. As NATO develops a more effective cross-domain deterrence posture consistent with the evolving battlespace of the future, it is critical to understand the factors contributing to adversary perceptions – in both strategic and tactical timeframes. Some potential adversary perceptions of importance relevant to the role of space in the deterrence strength of the Alliance include (1) the value of space to NATO; (2) NATO's resiliency to threats to its access to and use of space; and (3) the risk that actions taken regarding space may become escalatory.

Space's role in deterring aggression, on both sides of a potential conflict, is increasingly the subject of discussion and rhetoric; this is particularly true now that potential adversaries have weapons that can degrade or destroy critical space capabilities. Within the Alliance, the role of space in conflict deterrence must be examined in a much larger context as it becomes necessary to dissuade an escalating array of undesirable adversarial behaviors.

There are three key areas associated with space and deterrence within the Alliance that should be addressed. The first and perhaps the most important is the role that space plays in contributing to NATO's net deterrence posture through force enhancement as well as information dominance and operational domain awareness. In the anticipated cross-domain battlespace of the future, effective application of space capabilities will be critical. The second is the importance of deterring aggression against the national space capabilities provided to the Alliance¹³. Degradation or loss of space capabilities is likely to place NATO in a more vulnerable position with a corresponding decrease in its overall deterrence posture. The third area of focus (really a subset of the second) is resiliency against adversary threats to Alliance space capabilities with the intent to dissuade the Alliance from initiating, entering or continuing some military action not necessarily related to space. For example, deterring Alliance members from coming to the aid or defense of a NATO or non-NATO ally by threatening to degrade or destroy those space capabilities.

NATO's deterrence strength results from, among other things, the sum of all member nations' military capabilities along with the strength that comes from planned, managed and disciplined integration of those capabilities into a single, significant defensive force capability. The synergistic advantages that accrue from such things as joint doctrine and strategy, standardized military interfaces, processes and procedures, common command and control architectures, common training and exercise environments are huge and serve to message potential adversaries on the implied costs of aggression.

Among the dimensions that can be used to characterize the elements of the net deterrence represented by the Alliance, one of the more recent concepts is that of intra and inter-operational domains. From a deterrence perspective, the imperative to increase the integration of the space domain with the other operational domains is based on two primary observations. The first is that increases in perceived responsiveness and lethality are needed to underwrite the Alliance's message of deterrence through strength. The second is that potential NATO adversaries are also very aware of the leverage or force multiplying effect that space can bring to their own overall defense capability. Those adversaries can be well expected to assess and seek relative asymmetric advantages themselves through the force multiplying effect of space across their operational domain elements.

[13] The NATO Alliance does not own per se any space systems (satellites) although it did acquire and operate its own communication satellites from the early 1970's through the 1990's. All space capabilities currently used by the Alliance are provided by member nations, partners and international commercial entities.

2.0 SPACE CONTRIBUTIONS TO DETERRENCE

An essential element of deterrence is the ability to project strength along with the will and expertise to effectively apply such strength. Conversely, if adversaries perceive weaknesses, then deterrence strength may be diminished. Focusing first on strengths, the space capabilities made available to the Alliance contribute to its strength in several areas including:

- Information dominance of the Alliance
- Enhancement of Alliance forces
- Alliance counterspace capabilities
- The Alliance industrial base

2.1 Information dominance¹⁴

Information dominance is critical in the prosecution of today's military operations. Being comprehensively aware of the battle space, sensitive to indications and warning of threats, and capable of accurate and timely transmission of information is, among other things, essential for successful Alliance operations. The unique "high ground vantage point" of space and associated space capabilities provide a significant basis for information dominance.

The ability to be forewarned and aware of impending threats is an essential element of deterrence; minimizing the surprise attack or circumstance. Thus, an important component of information dominance is comprehensive awareness across all operational domains. Space provides both global environmental monitoring and synoptic surveillance (ISR) over areas of concern to provide indications and warning (I&W) of impending adversary operations. Such capabilities also enable the detection and warning of the launch and flight of missiles and other weapon delivery systems as well as the tracking of vessels at sea. Furthermore, satellite communication links enable the dissemination of information from space sensors and other sources (for example, UAVs) to users within operationally relevant timeframes; again, contributing to information dominance.

In addition to I&W, the ability of space data to provide the basis for attribution of observed events and activities to specific actors can be extremely valuable. Such capabilities underwrite the strength and gravity of inputs to military and civilian leadership decision making processes; another element contributing to NATO's confidence, responsive resolve and overall deterrence posture.

Before leaving the discussion of the deterrence role of space and information dominance it is worth noting that information dominance results from (1) superior awareness, (2) superior analytics and (3) superior information velocity. Future battlespaces are anticipated to be subject to extreme, as-of-yet experienced, high operational tempos. Those environments will be dominated by those combatants having the greatest capacity to comprehensively sense the battlespace, process incoming data and information streams and make decisions within extremely short intervals. Artificial intelligence as well as big and advanced data analytics used elsewhere within the Alliance for information dominance will further enable space to contribute to such capabilities.

[14] The concept of Information Dominance is not, perhaps never will be, defined to everyone's full satisfaction but for the purposes of this paper the U.S. Navy's definition is sufficient: "the operational advantage gained from fully integrating ... information functions, capabilities and resources to optimize decision making and maximize warfighting effects" from [U.S.] Navy Strategy for Achieving Information Dominance 2013-2017; United States Navy, 2013

2.2 Enhancement of NATO forces

Enhancement of forces by space is fundamental to the Alliance's deterrence strength. The geometric advantage space provides to visibility and coverage of the Earth's surface is a significant contributor to enabling persistent and pervasive surveillance and communication services throughout the regions of NATO concern and operations. Both terrestrial (including air and maritime) and space-derived ISR information can be rapidly compiled, processed and disseminated throughout the battlespace. Essential command, control and communication (C3) links are provided among NATO force elements across all operational domains via space. Space also enables position, navigation and timing services to NATO forces and weapons systems via global navigation satellite systems (GNSS)¹⁵. Although limited alternatives may exist for Alliance forces to acquire functional services like that provided via space (for example, terrestrial HF radio), in most cases they are not likely to result in same level of force enhancement.

2.3 Counterspace

A special case of NATO force enhancement via space is the ability of those forces to deny the access to and use of space by adversaries; counterspace. Just as NATO derives substantial strength from space, most potential adversaries also have the potential for leveraging space to their advantage. The ability to thwart adversary use of space is likely to be an important contribution to deterrence.

2.4 The Alliance Industrial Base

The strength of the Alliance's space industrial base also contributes to its net deterrence strength. In addition to the deterrence-related message resulting from a strong Alliance warfighting capacity is the resolve demonstrated through the significant investment in resources, materiel and non-material capabilities, policies, strategies and CONOPS. The demonstrated seriousness underlying the Alliance's commitment to leverage the new technical frontiers of space and cyber can be expected to be a valuable contribution to the message of strength and implied consequences. The ability of that industrial base to respond to changes and advances in technology, applications and manufacturing techniques contributes to the overall effectiveness and responsiveness of the member nations to changes in the threat environment.

The intellectual capital represented in the Alliance's space and related technical communities is substantial. The breadth of that community's ability to develop new capabilities and respond to threats brings a unique strength to the Alliance. Maintaining a healthy industrial base throughout the Alliance is paramount to sustaining that strength. The space domain is evolving and becoming a more technically complex environment in which to operate, particularly in a competitive and defensive manner. To be dominant in that domain will require the best and the brightest technical minds be applied to the Alliance's space strengths.

The net effect of the space domain's contribution to NATO's information dominance, enhancement of forces (including counterspace) and its industrial base is a stronger deterrence posture. That concept is shown in the simple graphic of Figure 1. However, as discussed next, there are counters to that deterrence strength, especially since the Alliance's adversaries are not unaware of the value of space to NATO or themselves.

[15] For example, GPS and, in the future, the Galileo system.

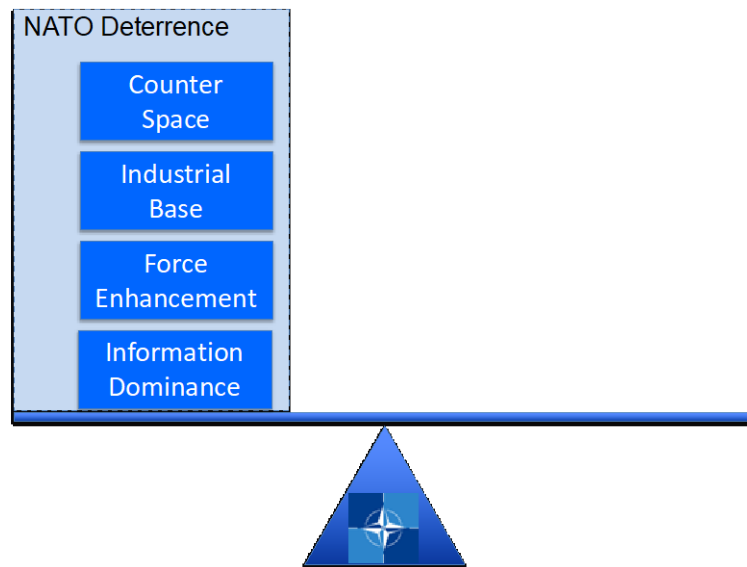


Figure 1: Space Contributions to NATO Strength.

3.0 FACTORS WEAKENING SPACE CONTRIBUTIONS TO DETERRENCE

As noted, space is an operational domain having its own vulnerabilities and risks. The contribution of space to NATO deterrence can be seriously weakened or degraded, potentially to a degree when other deterrence elements are rendered ineffective. Space is a hostile natural environment at the very least with space systems required to be designed to operate in high radiation environments, subject to collision with space debris, and unintentionally interfered with by terrestrial RF sources. In addition, the potential for adversary use of counterspace weapons and techniques to degrade or destroy NATO space capabilities has grown over the last decade. The reliance on space to contribute to the Alliance's deterrence posture must take into consideration the very real risks in and to that domain.

The deterrence value of a strong portfolio of space capabilities can be weakened via three fundamental avenues. First is an adversary's access to or use of a more capable portfolio of space capabilities to strengthen their own forces and as well as strengthening their own deterrence posture in a manner similar to that of NATO. The second is an adversary's use of counterspace effects to degrade or deny the use of NATO's space capabilities. And, the third are non-adversarial risks in, and to, the space domain that can impair or perhaps deny the effective use of the domain.

3.1 Adversarial Space Capabilities

Space and space technology is accessible to a growing number of nations throughout the world. Space capabilities and services can even be leveraged without owning or operating any space assets. The international commercial sector now provides an expansive array of space services and products to include communications, imagery and, soon, SIGINT capabilities. International providers of space object surveillance (traffic) data over the Internet is growing thus enabling a global understanding and awareness of many of the satellites in orbit and perhaps their missions. Furthermore, NATO's major potential adversaries have years of experience operating civil and military space systems and continue to evolve their space support to operations throughout their force structures. They too will use space to seek information dominance and enhancement of their forces.

However, the mere ownership or operation of satellites is not, by itself, a useful metric of space deterrence strength. For example, China, Russia as well as several NATO member nations have communication satellites that support military functions. The ownership of such satellites is necessary, but far from sufficient, from which to derive deterrence strength. Beyond the technical capabilities of the hardware, deterrence strength comes from the ability to integrate satellite communications into operational C3 architectures, utilize effective CONOPS for operating communication links in degraded or denied RF environments, resiliency of hardware (both on-orbit satellites and user equipment on the ground) to hostile attack and environmental risks, etc. The increased experience in the use of space by adversaries and the evolution in the sophistication of their application of space to military pursuits will necessarily weaken the deterrence strength that NATO may currently and uniquely derive from space.

3.2 Adversarial Counterspace

The increasing potential for NATO's likely adversaries to use counterspace applications to deceive, degrade, disrupt, deny, or destroy the space capabilities of the Alliance significantly challenges any deterrence contributed by those capabilities. This becomes of concern if the adversary continues to use space to their advantage while those of the Alliance have been impaired or eliminated.

There are many references on the current state of counterspace approaches and weapons that provide the essential insights into the nature of such threats.¹⁶ For the purposes of this paper it is sufficient to stipulate that counterspace capabilities are real and pose a significant challenge in the application of space in any deterrence calculus.

There are several ways of characterizing counterspace capabilities. For example, they can be defined by the means of attack (kinetic energy, direct energy, RF interference, etc.) or on a continuum from reversible (meaning that once the attacking force is "turned off" the affected space system returns to normal with little or no permanent damage done) to irreversible (meaning that the target of the counterspace effect is permanently damaged or destroyed with little or no possibility of recovery). In the context of deterrence, it really doesn't make much difference whether it is reversible or not, the consequence is potential loss of some degree of space capability, possibly at a critical time, thus incurring weaknesses that weaken deterrence.

3.3 Non-Hostile Risks and Hazards

Another challenge to space contributions to deterrence comes from non-hostile risks and hazards associated with the domain. If not accommodated or prepared for, these situations could undermine NATO deterrence. There are three general categories of such risks and hazards:

- Space environmental effects
- Engineering and operational risks
- Institutional risks

The space environment is a rather hostile place for hardware especially those with sensitive mechanical and electronic components. The first concern relative to the space environment is the risk of impacts to satellites from space debris. At the high velocities of objects in space (satellites in low earth orbits travel at approximately 7.5 km per second) collisions with even very small objects can be destructive. With the increasing amount of discarded space junk, dead satellites and debris from explosions, collisions and weapon tests there is increasing concern over the resiliency of hardware to such impacts. Unless world-wide measures are adopted and taken seriously to minimize collision hazards this problem will only increase.

[16] Weeden, B. and Samson, V., Global Counterspace Capabilities: An Open Source Assessment; Secure World Foundation, April 2018

The second concern is from the natural ionizing radiation transiting space that impinges upon spacecraft and their electronics. That radiation comes from three different sources, solar events (flares), trapped solar radiation particles surrounding the Earth and cosmic radiation from deep space. The effect of radiation on a satellite's sensitive electronics can range from minor, recoverable errors in a digital circuit to permanent damage of electronics and materials. A challenge can be posed when the effects of space radiation on satellite electronics may not be easily discernible from the effects from an intentional electronic attack; a potentially important issue for appropriate attribution of an observed satellite anomaly.¹⁷

Third, unintentional radio frequency (RF) interference from terrestrial and perhaps space sources can also degrade space-to-ground communication links to the point where critical C3 functions can be seriously impaired. Like mitigating RF interference in terrestrial environments, there are technical and CONOP solutions to mitigating such situations; however, they are not always as easy to implement for space links due to the limitations of the equipment on-orbit. It can be anticipated that because of both intentional (via electronic warfare) and unintentional RF interference, critical NATO C3 capabilities are likely to be degraded to some degree.

Engineering risks are always present in any technically complex system deployed in offensive or defensive roles. For the purposes here, engineering risks encompass both shortcomings in the inherent system design as well as manufacturing quality issues. A widely understood (i.e., public) track record of engineering shortcomings may erode the perceived deterrence strength of any affected military capability including space. For example, a poor track record of launch or on-orbit failures would be expected to significantly erode the potential deterrence contribution to NATO of a nation's space capabilities.

Risks to the availability of space systems and their services may become an issue when specific Alliance member nations providing space capabilities are, for whatever institutional or political reason, unable or willing to provide those capabilities to NATO. The reasons may include internal sovereign political challenges to specific NATO operations, pressure from sovereign or international commercial sector customer bases, or outright threats to specific national space capabilities vital to sovereign governance and economic well-being.

The impact on deterrence from the reduction in the magnitude of space capabilities available to NATO will be situationally dependent, but will be a function of the contribution of the withheld capabilities to the overall NATO space capability posture. Since NATO does not own any space systems and its space capabilities are provided via the sovereign capabilities of the nations, institutional risks should not be overlooked when assessing the contribution of space to NATO's deterrence posture. Historically there are no known situations of this sort that have ever occurred. However, in the spirit of completeness of considering downside risks to space in the NATO context, the potential for such scenarios should be considered. Minimizing dependencies upon space and single sources of space capabilities is a potential mitigating strategy.

Figure 2 shows the balance of space contributions to deterrence (from Figure 1) against the factors just discussed that can weaken those contributions to deterrence. This simple framework allows one to consider the degree of mitigation necessary of those factors to ensure that space contributes to NATO deterrence as well as the efficacy of potential concepts and strategies for enhancing deterrence via space.

[17] The ability to accurately and confidently attribute the source of an apparent attack is an important contributor to deterrence.

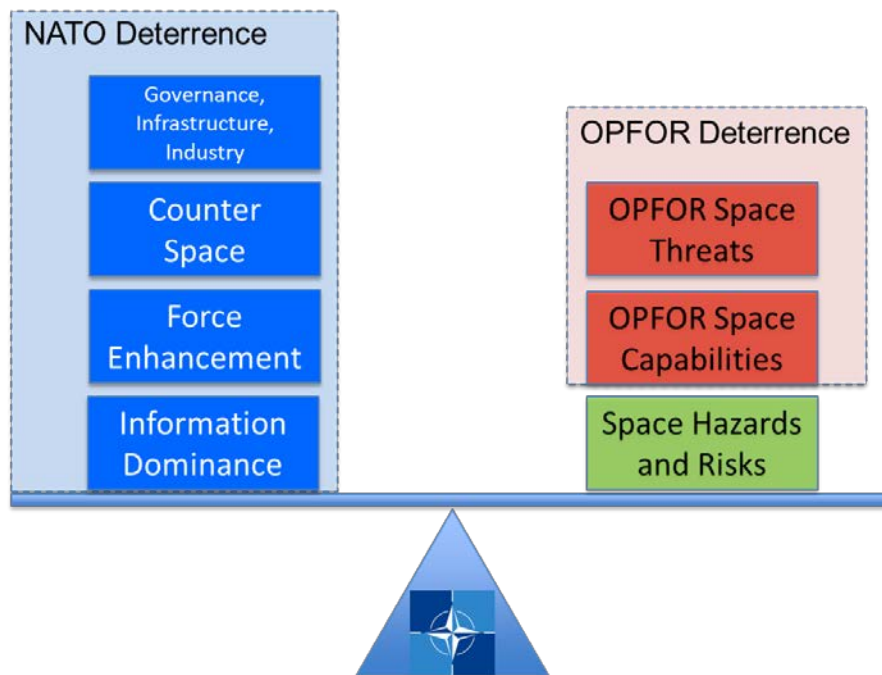


Figure 1: The NATO Deterrence Balance Relative to Space

4.0 CONSIDERATIONS FOR SPACE AND NATO DETERRENCE

As with deterrence strategies *writ large* there are no guaranteed prescriptive measures relative to space that will consistently yield a strong deterrence posture for NATO. This is particularly true for space because of the relatively limited experience with identifiable evidence of deterrence success in a contested environment or circumstance because of space. Within the global geo-political realm, the space domain has generally played a supporting role to factors with significantly more gravity in terms of the application of military or diplomatic strength. That said, the growing role space plays in the ever-increasing complex technical interdependencies among nations suggests that the domain will become a more important consideration for theorists and practitioners of deterrence strategy.

Using the simple framework of contributing and eroding space deterrence factors one can posit two classes or groups of potential actions that might be useful. The first class increase the real and perceived strength imparted by space to the overall deterrence posture of the Alliance. The second are concepts that mitigate against the potential actions taken by an adversary to directly reduce the contribution space makes to the Alliance's deterrence posture and those from non-adversarial hazards and risks.

4.1 Increasing the Deterrence Value of Space

One of the most important considerations for ensuring the positive contribution of space to the net NATO deterrence posture is the intrinsic quality and quantity of the space capabilities provided by its member nations that can be leveraged effectively by the Alliance. This inherently implies capabilities that are better than, and can be more effectively utilized than, the space capabilities of potential adversaries. This means, among other things, having more advanced space systems; for example, systems with higher data sensing and transmission rates or greater observational persistence over the battlespace. It also means capabilities that are interoperable and seamlessly accessible throughout the NATO force structure. And finally, it means

that Alliance forces and their command structures are sufficiently trained and competent to maximally leverage those capabilities.

In addition to having technically superior space capabilities enhancing NATO's forces over those of any adversary it is also essential for those capabilities to be resilient to any threats and hazards imparted to the domain. Satellites, for example, must be able to withstand hostile engagements intended to degrade or destroy their capabilities as well as space environmental hazards that are faced throughout their operational life. And, as noted, spacecraft must be minimally free from effects of engineering shortcomings and not constrained in their use by institutional or political factors. Furthermore, the ground infrastructure required to place satellites into orbit and control them once there as well as ground equipment that interface with users must also be resilient to all intentional or unintentional threats and hazards.

NATO must also manage the messaging and resulting adversary perceptions associated with these (superior) capabilities to achieve the desired deterrence posture. Too little messaging and the deterrence strength derived space may be inconsequential. On the other hand, too much might be escalatory and may result in adversary enhancement of their own space capabilities; in effect, leading to a space arms race. With respect to the latter, there has always been a sense that potential adversaries (within the limits of their ability) constantly seek to achieve parity with the space capabilities of the Alliance.

Some example messaging content that may usefully contribute to or modulate significant adversary perceptions with respect to NATO's space capabilities include:

- The nature and scope of space capabilities for force enhancement
- Degree of space domain awareness (for I&W and attack attribution)
- Degree of information dominance enabled by space
- Strength of the civil governance and civil infrastructure enabled by space
- Degree of integration of space into C3 architectures and CONOPS
- Sophistication of training and education on space operations throughout NATO
- Resiliency to hostile counterspace attack
- Resiliency to environmental hazards and engineering risks
- Existence of counterspace capabilities and associated NATO doctrine
- Strength of institutional and political commitment to provide space capabilities

There are many avenues for inherent and intentional messaging of space's role in the strength of the NATO Alliance. Clearly, potential adversaries monitor through open and clandestine means the force structure of the individual Alliance members and the specific capabilities of their weapon and supporting systems such as space. From that insight they develop their perceptions of the contribution such capabilities make to the strength of the Alliance. Furthermore, they can be expected to take note of how those capabilities are integrated and used in an interoperable manner throughout the Alliance during real world NATO operations (such as ISAF¹⁸) and in NATO large scale exercises. Regarding the latter, in the last three years NATO has incorporated space support in operations into the Trident series of exercises starting with Trident Juncture 2016. As NATO officially recognizes space as a domain of operations and demonstrates its essential and contributing value as integrated into NATO force capabilities, it will be noted.

Managing many of these perceptions will be difficult since space capabilities are provided to the Alliance from the member nations, each with their own deterrence messaging requirements relative to space. Consequently, there is a net messaging theme that accrues from the totality of all space capabilities provided.

[18] The International Security Assistance Force; the NATO-led security mission in Afghanistan

Probably any net perceived strength will result from a combination of the perception of the magnitude of the specific national capabilities provided and the perception of the degree to which those separate sovereign capabilities are effectively integrated to result in a net NATO capability that is greater than the sum of the individually contributed capabilities. Stepping back, fundamentally that is the basis for the deterrence strength of the Alliance; an integrated net force capability that results from effective integration of the individual force strength from each nation.

Although difficult for the reasons noted above, it may be useful to manage adversary perceptions by holding back information on NATO's full capabilities with respect to space. That may forestall escalation and undesired improvements in adversary space capabilities; although global proliferation of enabling advanced space technology makes probably that only a temporary option.

On the other hand, managing inflated perceptions of NATO's space capabilities may be necessary. Perceptions that NATO has capabilities in space that it doesn't actually have might, perhaps, yield some near-term deterrence. However, an adversary that has the wherewithal may be incited to put in the effort to develop what they perceive as comparable capabilities, leaving the Alliance then behind with possibly inferior space capabilities. More likely though, adversaries are not going to attempt to duplicate a non-existent NATO space capability, but rather be incentivized to take other actions to counter other NATO strengths to thwart the perceived asymmetric advantage; again, fuelling the potential for an escalatory environment.

4.2 Minimizing the Weakening of the Deterrence Value of Space

Equally as important to projecting deterrence through implicit and explicit messaging of the Alliance's strength in and from the space domain is messaging that NATO's space capabilities are resilient to degradation or loss and further, that any attempt will be successfully mitigated, if not also retaliated against. In other words, the effect of any attempt by adversary to attack those capabilities will be mitigated with consequences.

The fundamental imperative here is keeping the (terrestrial) fight from adversely affecting the Alliance's presence in space domain thereby leading to a reduction in NATO's overall force strength. If the adversary perceives that it can effectively degrade or deny the Alliance's space capabilities and thereby increase their chances of prevailing, then they may not be deterred from aggression or other inimical behaviors. The necessary NATO deterrence message is that its space capabilities, as provided by the individual nations and as utilized throughout the Alliance, are resilient to attack or extortion. And, furthermore, that attacks against Alliance space capabilities will be costly to the attacker at the very least and may result in other significant consequences.

Again, the challenge for deterrence underwritten by space in the NATO context is that all space capabilities are provided by the nations. The nations have the sole sovereign responsibility for their design including their resilience to natural, unintentional and intentional harm. They are also responsible for their operations and CONOPS to mitigate against such harm. Currently there are no means (nor are any planned) for NATO command constructs to intercede in the command or control of those provided space capabilities to provide such mitigation at the NATO level. Consequently, the net resiliency of the on-orbit NATO space capabilities is the aggregate resiliency across all nations' space capabilities as they are individually operated.

The messaging of specific system resiliencies to specific threats, risks or hazards is solely up to the sovereign owner / operators of those systems. Many resiliency features and capabilities are, not unexpectedly, classified to preclude countermeasures from being developed or vulnerabilities from being exploited. Thus, resiliency at the space system (i.e., satellite) level is probably not something that will contribute much at the NATO level of deterrence messaging.

On the other hand, NATO space capabilities do afford the opportunity to message resiliency through the inherent integration of capabilities at the service and information levels. For example, integrated capabilities that provide interoperability across the space services and products provided by the individual national space systems enable more resilience in support to forces. An attack or degradation against one system might be mitigated through the seamless transition to the use of another nation's system. Common training for NATO forces on contingencies involving space service outages (for whatever reason) further increases the net resilience of NATO's space strength. Command post and live fire exercises requiring responses to such service outages are examples of how messaging might be accomplished in that regard; for example, training under GPS or SATCOM jamming scenarios.¹⁹

Albeit perhaps not as effective, the existence of non-space capabilities that can partially substitute for lost or degraded space capabilities also brings a degree of net resilience to NATO operations. The ability, for example, to seamlessly transition users from SATCOM links that have been jammed to a high frequency (HF) terrestrial radio links to accomplish mission functions renders a degree of resilience; an example of cross-domain, interoperable C3 architectures. The same holds for the availability of (and ability to use) alternative navigation and position aides when satellite navigation signals are jammed or otherwise unavailable or reliable.

In addition to messaging the resilience of NATO space capabilities it is also important to message the consequential costs of attacking those capabilities. Again, this is a necessary combination of the national responsibilities for responding to attacks against sovereign "property" and the collective Alliance doctrine for response to adversarial counterspace attacks. Individual nations are responsible for messaging (or not) what they would do under such circumstances in a manner of their choosing; for example, specific actions or managed ambiguity. Presently NATO does not have specific response doctrine or policy concerning attacks against the space capabilities of its member nations during NATO operations. That may have to change in the future.

5.0 CLOSING OBSERVATIONS

As a final deterrence-related consideration, the potential exists for an adversary to threaten a counterspace attack against NATO's provided space assets with the intent to deter action in another operational domain or coerce some other outcome. In other words, holding NATO space capabilities at risk as a deterrence against NATO's pursuit of specific mission objectives. Experiences in the cyber domain are perhaps a view to that future possibility.

There is an increasing potential for adversaries to use the threat of cyber-attacks on critical infrastructure (including civil and financial institutions) to extort or coerce their opponents to submit to their will. On a small scale this has already been manifested by various malware-based criminal extortion schemes on commercial and government enterprises, but not yet experienced in the context of war and conflict among nation states. However, the risk continues to grow with the ever-increasing reliance on cyber-based enterprises and their increasingly complexities. Those complexities contribute to an increasing degree of unknown and un-knowable vulnerabilities, interdependencies and other implications and consequences. The situation faced by those that rely on the space domain is probably similar and related; and not just because of the high degree of cyber systems involved in space systems.

[19] The recent Trident series of NATO command post exercises exposed the training audiences to a range of scenarios in which operations in a contested and congested space domain must be addressed.

It has been posited by some, including the Chinese²⁰, that attacking or threatening to attack one's adversary's space capabilities can be used to deter some non-space behavior or activity. The assumption is that the space capabilities of one's adversary are so valuable to them that the cost of their loss is much higher than the value of their perceived objective. Space capabilities might then be held hostage to deter some other military or diplomatic pursuit. Scenarios such as this may put space up front in the larger NATO deterrence strategy picture. For NATO the threat of extortion via space is really a matter of extortion-based adversary deterrence focused at the individual nation level, since they provide the Alliance with its space capabilities. The rationale and ramifications of this line of thinking needs to be explored further since it could conceivably be used to extort a wide array of conditions affecting NATO.

In closing, this paper advances the concept that space is an important contributor to the strength of the NATO Alliance and as such contributes to its net deterrence strength. As the Alliance acknowledges and becomes more comfortable with space as a domain of operations and its necessary role in assuring the success of its missions, it will be necessary to more purposefully consider the domain's role in deterrence. Sustaining a superior strength in the space capabilities provided to NATO is essential as will the critical need to protect those capabilities from intentional and unintentional harm. As part of the Alliance's deterrence calculus it will be essential to adopt policy and doctrine that address intentional threats to its space capabilities to underwrite a unified message of the consequences as an integral component of the overall NATO deterrence posture.

[20] Cheng, D., *Evolving Chinese Thinking About Deterrence: What the United States Must Understand About China and Space*, The Heritage Foundation, No. 3298, 29 March 2018