Extending Operational Reach: A Future Chinese Threat Scenario to the US Space Domain

A Monograph

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14. ABSTRACT

Over the last few decades the US military has seen a Revolution in Military Affairs in regards to the development of new technologies; specifically space-based assets. The US Army has transitioned from previously used techniques for navigation and communications to a more technology focused technique employing Global Positioning Satellites and the use of satellite communications. China has observed this shift of military affairs from the US and has developed strategies to counter the America's perceived advantage in the space domain. China has developed a robust Anti-Access/Area Denial Capability (A2/AD) that focuses on disrupting or degrading the US Military's reliance on technology; specifically those space-based assets that provide navigation, positioning, and timing, satellite communications, and imagery to name a few. The new concept of Multi-Domain Battle (MDB) and the creation of a Multi-Domain Task Force (MDTF) were created so that US forces continue to have advantages in all domains and threaten their ability to maintain overmatch.

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Abstract

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Over the last few decades the US military has seen a Revolution in Military Affairs in regards to the development of new technologies; specifically space-based assets. The US Army has transitioned from previously used techniques for navigation and communications to a more technology focused technique employing Global Positioning Satellites and the use of satellite communications. China has observed this shift of military affairs from the US and has developed strategies to counter the America's perceived advantage in the space domain. China has developed a robust Anti-Access/Area Denial Capability (A2/AD) that focuses on disrupting or degrading the US Military's reliance on technology; specifically those space-based assets that provide navigation, positioning, and timing, satellite communications, and imagery to name a few. The new concept of Multi-Domain Battle (MDB) and the development of a Multi-Domain Task Force (MDTF) will create a relative position of advantage for US forces in all domains against adversaries that threaten these critical space-based capabilities. The research compiled for this monograph comes from sources such as RAND, Strategic Studies Institute, and other authors on the China threat from the A2/AD perspective to overmatch the US Military's advantages in the space domain. This monograph attempts to nest space capabilities within the construct of this new concept. Also highlighted is the US Army Space and Missile Defense Command's Army Space Training Strategy's recent attempts to provide training to US Army units on degraded space environments during home-station and Combined Training Centers (CTC) training events.

Contents

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The help I received from the folks at the US Army Space and Missile Command was amazing. LTC Ed Cardinalle and MAJ Jake Frazier provided me with the latest and most relevant information on the Multi-Domain Battle concept and the Multi-Domain Task Force. Ms. Joan Rousseau and her Army Space Training Strategy team provided me with all the relevant training data to add evidence towards answering my hypothesis. Mr. James Lee also provided me with very helpful suggestions to construct my methodology and other parts of this monograph. Thank you all for taking time from your schedule to assist me in this important and fulfilling endeavor.

My last thanks go to Rusty from the Combined Arms Research Library on Fort Leavenworth. His countless hours of researching possible resources on various library databases helped me immensely in focusing my research.

Acronyms

A2/AD	Anti-Area/Area Denial
ASBM	Ant-Ship Ballistic Missile
ADP	Army Doctrine Publication
ASAT	Anti-Satellite Weapon
ASTS	Army Space Training Strategy
CALL	Center for Army Lessons Learned
CATS	Combined Arms Training Strategy
D3SOE	Denied, Degraded, Disrupted Space Operations Environment
EW	Electronic Warfare
FM	Field Manual
GPS	Global Positioning System
ISR	Intelligence Surveillance and Reconnaissance
JCS	Joint Chiefs of Staff
JTIDS	Joint Tactical Information Distribution System
MDB	Multi-Domain Battle
MDTF	Multi-Domain Task Force
NTC	National Training Center
PLA	Peoples Liberation Army
PACOM	Pacific Command
RMA	Revolution in Military Affairs
SATCOM	Satellite Communications
US	United States
USARPAC	US Army Pacific
USASMDC	US Army Space and Missile Defense Command

Illustrations

Introduction

> We need to train a Space Mission Force. We need our space operators focused on what to do in case of a threat and to operate through the threat environment.
>
> —Gen John Hyten, *Vision for Command at Space Symposium*

The space-race between the United States and the Union of Soviet Socialist Republic post World War II saw an emergence of what many have coined a revolution in military affairs (RMA).[1] It brought these two countries and much of the world into a new era and with that a new characteristic of warfare. Space-based assets such as Global Positioning System (GPS) and Satellite Communications (SATCOM) have elevated the United States into positions of advantage by extending the modern battlefield like never before. This revolution of space technology is what the theorist Thomas Kuhn would call an anomaly that could lead to a paradigm shift.[2] This space technology is not a paradigm shift as Kuhn defines it but it has led to a change in the characteristics of warfare over the last few decades. The US military has incorporated the use of these technologies into its doctrine and operational framework. Many states on the global scale have carefully dissected this position of advantage that America currently has in space. Peer adversaries, such as China, have developed their own space-based capabilities and effective means to counter the America's advantage.

China has emerged over the last decade from the realm of near-pear adversary to peer adversary. Much of this change in status for China is due to their investment in emerging technologies, specifically space-based technology. China has made huge strides in their space launch and spacecraft capabilities over the last several years. In 2013, China sent a rocket and a

[1] William Burrows, *This New Ocean: The Story of the First Space Age* (New York: Random House, 1998), 177.

[2] Thomas Kuhn, *The Structure of Scientific Revolution* (Chicago: University of Chicago, 1970), 58.

rover to the moon in 2013, which was a first for a country in thirty-seven years.[3] Of more concern than China's space launch ability, is their counter-space strategies.

After the end of the cold war, America materialized as the space leader among the nations of the world. The United States developed such technologies as GPS, missile warning, and other space-enabled intelligence platforms that established a marked advantage for its military. Many countries, such as China, watched and learned this evolution and developed strategy to counter these advantages. China has developed a counter-space strategy that involves creating a denied, degraded, disrupted space operations environment (D3SOE) for the United States government and military in future conflicts. The Peoples' Liberation Army (PLA) of China has "emphasized the necessity for destroying, damaging, and interfering reconnaissance and communications satellites, suggesting that such systems, as well as navigation and early warning satellites, could be among the targets of attack designed to blind and deafen the enemy."[4] The ways in which China plans to employ its counter-space strategy is through the creating of an Anti-Area/Aerial Denial environment (A2/AD) and the use of an anti-Satellite weapon (ASAT).

A notable advancement of Chinese military space capabilities took place on January 2007 when China successfully tested an anti-satellite weapon (ASAT).[5] The sole function of an ASAT is to counter the advantage the United States has in space by destroying strategic space-based assets. China also demonstrated this capability by successfully destroying its own satellites on orbit in 2013. China has also invested large sums of its military budget towards is in the A2/AD environment of jamming. "The PLA's Electronic Warfare (EW) commands have conducted jamming and anti-jamming operations, testing the military's understanding of EW weapons,

[3] Chris Impey, "How China Entered the Space Race," *Wired*, April 15. 2015, accessed October 15, 2017, https://www.wired.com/2015/04/how-china-entered-the-space-race/.

[4] Steven Colley and Anthony H. Cordseman, "Chinese Strategy and Military Modernization" (Washington, DC: Center for Strategic and International Studies, 2015), 52.

[5] Angel Cruz, "The Strategic Shift to the Asia-Pacific" (Monograph, Naval Postgraduate School, 2014), 12.

equipment, and performance, and improving its confidence in conducting force-on-force, real-equipment confrontation operations in simulated EW environments."[6] China has developed an extensive capability in the operational realm of jamming by acquiring new technologies in this area and through the creation of organizations with the mission of interfering with its adversary's space-based capabilities. One US development that may help mitigate China's A2/AD capabilities is the creation of Multi-Domain Battle (MDB) concept and Multi-Domain Task Force (MDTF).

The Multi-Domain Battle concept began as a joint US Army and Marine Corps white paper in October 2016. This white paper states, "[a]dversaries will counter US strengths such as air and maritime superiority, and degrade key capabilities by limiting access to space, cyberspace, and the EMS. Adversaries will also exploit perceived US weaknesses such as time and distance for force deployment, logistics nodes, and vulnerable command and control networks."[7] The Multi-Domain Battle concept was developed at the time when the United States military was in a transformation state between its counter-insurgency conflicts in the Middle East to the prospect of dealing with a peer adversary on the modern battlefield. A significant aspect of this concept is the evolution of the Multi-Domain Task Force. GEN Milley stated that this task force is "a relatively small organization, 1,500 or so troops, capable of space, cyber, maritime, air, and ground warfare. They are smaller dispersed, very agile, very nimble organizations that are networked into other lethal systems that delivered by either air or maritime forces that will be essential to rip apart the A2/AD networks."[8] This relatively small task force could play a vital role in countering peer

[6] US Government, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2017* (Washington, DC: Office of Secretary of Defense, 2015), 35.

[7] Michael Redman. "Multi-Domain Battle: Combined Arms for the 21st Century" (White paper, Army Training and Doctrine Command, Army Capabilities Integration Center, Concept Development and Learning Directorate, Joint and Army Concepts Division, Washington, DC, 2016), 5.

[8] Sydney Freedberg, JR. "New Army Unit to Test Tactics: Meet The Multi-Domain Task Force," *Breaking Defense News*, March 21, 2017, accessed October 7, 2017, http://breakingdefense.com/2017/03/new-army-unit-to-test-tactics-meet-the-multi-domain-task-force/.

adversaries, such as China, strategies against the United States. A training strategy that the army has developed in the last few years to combat the A2/AD environment, specifically in the space domain, is led by the US Army Space and Missile Defense Command (USASMDC).

In 2011, an Army Strategic Space Plan was published that highlighted the need for institutional training for a degraded space environment across all levels of command.[9] US Army Space and Missile Defense Command is the proponent responsible for this training across the force. The plan USASMDC adopted for ensuring units are receiving this foundational training for a degraded space environment is through the Army Space Training Strategy (ASTS). US Army leaders signed this strategy in November of 2013. It provides an integrated framework to educate and train Soldiers at every grade level and echelon about current space capabilities available to them and mitigation procedures when those capabilities become contested.[10] One aspect of this training that this monograph will highlight is analysis of the Combined Arms Training Centers (CATS) results of operating in this degraded space environment training.

This research relies on two hypotheses. First, the concept of Multi-Domain Battle and the future creation of the Multi-Domain Task Force will ensure that the US Army creates opportunities for the land component to exploit against peer adversaries, and it will ensure that these forces can effectively operate in an Anti-Access/Area Denial environment (A2/AD).[11] Secondly, the mandated Army Space Strategy and the creation of the ASTS will educate and train Army forces to operate in a degraded space environment. The research for this monograph will answer the question associated with these hypotheses. Can the US Army effectively operate in a degraded space environment?

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[9] US Department of the Army, *Army Strategic Space Plan* (Washington, DC: Department of the Army Space Strategy, 2011), 7.

[10] US Department of the Army, *Army Space Training Strategy* (Washington, DC: US Army Space and Missile Defense Command, 2013), 9.

[11] Jeffrey M. Reilly, "Multidomain Operations: A Subtle but Significant Transition in Military Thought," *Air and Space Power Journal*, Volume 31, Issue 1 (Spring 2016), 35.

Methodology

This study utilizes the structural of an in-depth single case scenario to construct findings that indicate the feasibility of the Multi-Domain Battle concept to counter an A2/AD and degraded space environment. This study will also examine the futility of the ASTS to assist future army formations in this degraded operational construct. China's resurgence on the global stage in the last several years is the lens that this study will use to determine the feasibility of the Multi-Domain Battle concept and the ASTS.

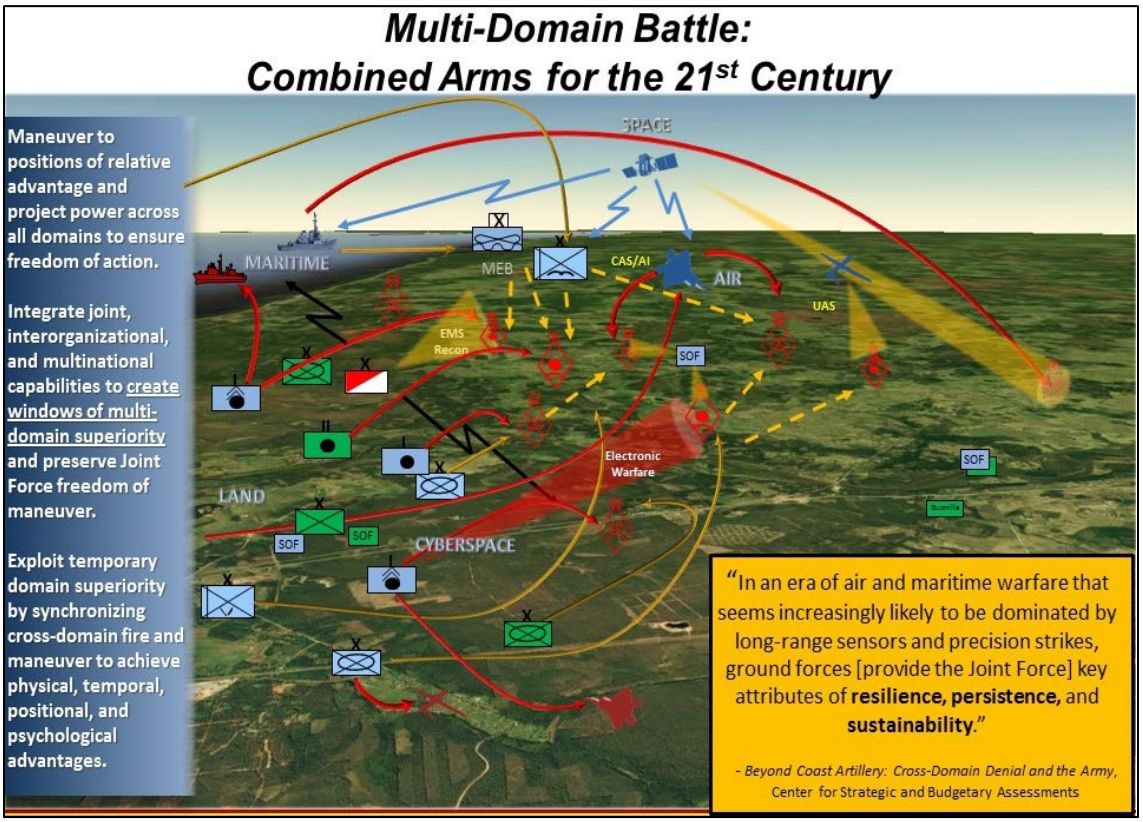

Figure 1. Multi-Domain Battle Concept. Michael Redman, "Multi-Domain Battle: Combined Arms for the 21st Century" (White paper, Army Training and Doctrine Command, Army Capabilities Integration Center, Concept Development and Learning Directorate, Joint and Army Concepts Division, Washington, DC, 2016), 5.

This research is an exploration of how a modern military might fight effectively in an A2/AD conflict, specifically in a GPS degraded environment. China has invested much of its time and energy in countering the US advantage in space-based technologies over the last few decades. They are attempting to create increased fog and friction to war that the renowned war theorist, Carl von Clausewitz, spoke of in his writings. Clausewitz stated "three quarters of the factors on which action in war is based in a fog of greater or lesser uncertainty.[12]" This study highlights China's willingness and capability to impose both fog and friction on the modern battlefield to counter US technological advantages in the space domain.

This case scenario framework is comprised of two examples of China's demonstrated abilities to use lethal effects against American space assets in the form of an ASAT weapon. This research also demonstrates Chinas increasing capabilities in the realm of non-lethal effects, such as GPS jamming, to exploit US reliance on technology. These effects are explored using examples as a mechanism that demonstrates Chinas effectiveness to create conditions for an A2/AD environment in all five domains.

Another integral facet of the methodology is aimed at examining the ASTS developed in 2013. This strategy is an ongoing initiative that incorporates home-station training at Ft. Carson, Colorado for the Forth Infantry Division to the CTC rotational training conducted at Ft. Irwin, California. This part of the research provides a framework of analysis that demonstrates the effects of an A2/AD and degraded space environment at the tactical and operational levels of war during a units training rotation at the National Training Center (NTC).[13]

[12] Carl Von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 101.

[13] US Department of the Army, *Army Strategic Space Plan*, 5.

Literature Review

The Multi-Domain Battle concept was the creation of GEN Mark Milley, the 39th Chief of Staff of the Army. Milley understood that the counterinsurgency fights in the Middle East have left the US military challenged by peer advisories in Eastern Europe and East Asia. Milley stated, "[l]and-based forces now are going to have to penetrate denied areas for the rest of the joint force while having the capacity to operate in all domains simultaneously."[14] The real opus of this concept began with the drafting of the joint white paper from the US Army and Marine Corps in October 2016. This white paper garnered much attention from policy makers on Capitol Hill, to military leaders through the United States military, to media correspondence. This white paper reverberated across the joint force by signifying a possible change in how the US Army would conduct operations. This paper argues that the crux of the problem statement is ground combat forces, operating as part of joint, inter-organizational, and multinational teams, are not sufficiently trained, organized, equipped, nor postured to deter or defeat highly capable peer enemies to win in future war.[15] The introduction into army doctrine codified this concept into a reality for the army and joint force.

This concept of Multi-Domain Battle made its debut into Field Manual (FM) 3-0, *Operations*, dated October 2017. This inclusion into doctrine catapults this from a conceptual concept to an operational framework to replace the AirLand Battle doctrine that has been the cornerstone for the army's operational and tactical doctrine for many years. FM 3-0 highlights this change in chapter one of the manual when it states "[t]he Army conducts operations across

[14] Nathan A. Jennings, "Realign the Army for Multi-Domain Battle" (Washington, DC: Association of the United States Army, April 17, 2017), accessed October 24, 2017, https://www.ausa.com.

[15] Michael Redmen, "Multi-Domain Battle: Combined Arms for the 21st Century," 7.

multiple domains and the information environment. All Army operations are multi-domain operations, and all battles are multi-domain battles."[16]

Many leaders in the US Army have speculated on the efficacy of shifting of focus from AirLand Battle doctrine to the new Multi-Domain Battle concept. The reason this is required is documented in the US Army and Marine Corps White Paper from September of 2017. It states the reason for this new concept is that an increasing number and range of actors are achieving the ability to further deny or disrupt friendly forces' access to and action within air, maritime, space, and cyberspace domains from extended distances. Their capabilities challenge the joint force's ability to achieve military and political objectives.[17]

An instrumental figure in the development of this new concept has been the Training and Doctrine Commander, Lieutenant General David Perkins. In an article from June of 2017, Perkins highlighted that the way ahead for transformation this from a concept into a reality is in three main efforts: Collaboration, wargames, and doctrine.[18] As previously discussed, the doctrine consist of the publication of FM 3-0 Operations. Collaboration is ongoing in the form of cross-services and through multi-national forces working on this new concept. The wargames piece of this will be in the form of exercises. This paper will discuss all of these efforts in detail in other sections.

Michael C. Davies asserts that this new concept is a move in right direction but not enough to prevent America from its continued course of losing wars. He believes that for this concept to be effective is by eliminating individual services and rebuild them as cross-functional

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[16] US Department of the Army, Field Manual (FM) 3-0, *Operations* (Washington, DC: Government Printing Office, 2017), 1-77.

[17] US Department of the Army and Navy, *US Army and Marine Corps Concept Multi-Domain Battle: Evolution of Combined Arms for the 21st Century 2025-2040* (White Paper, September 11, 2017), 12.

[18] Sydney J. Freedberg, "From Concept to Combat: Making Multi-Domain Battle Real," *Breaking Defense*, July 26, 2017, accessed October 30, 2017, https://breakingdefense.com/2017/07/from-concept-to-combat-making-multi-domain-battle-real/.

corps. [19] His arguments are in line with the whole of government approach and various lines of effort for successful mission accomplishment for the United States military's future endeavors. This counter-argument requires more research than can be covered in this paper but it still needs further investigation to test the validity and feasibility of this new concept.

A key component of this Multi-Domain Battle concept is the creation of the Multi-Domain Task Force (MDTF). GEN Milley is also the founder and creator of the concepts behind the MDTF concepts, to include its organizational structure. Freedberg quotes Milley as stating, "[t]his organization will be capable of space, cyber, maritime, air, and ground warfare."[20] The creation of this task force is an ongoing initiative within the army that will provide input for this task force's essential task, capabilities, and primary functions described in length in a Headquarters Department of the Army Executive Order from September of 2017. A major player in the creation of the MDTF is US Army Pacific Command (USARPAC), currently commanded by GEN Robert Brown.

Under Brown's supervision, USARPAC will employ these concepts in a series of major exercises in Fiscal Years 17 and 18 to test its validity against a peer competitor in a wargame environment. Brown stresses in a recent article that cross-domain effects are not entirely new and uses an example of the multi-domain effects with the introduction of the airplane and submarine during World War I. He states that to achieve success with this new approach, that there has to be a change in mind-set and culture. Brown describes the three essential elements of the Multi-Domain Concept as joint integration, technology, and people.[21]

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[19] Michael C. Davies, "Multi-domain Battle and the Masks of War," *Real Clear Defense* (May 11, 2017), accessed October 30, 2017, https://www.realcleardefense.com/articles/2017/05/11/multi-domain_battle_and_the_masks_of_war_111360.html.

[20] Sydney J. Freedberg, "New Army Unit to Test Tactics: Meet the Multi-Domain Task Force," 3.

[21] Robert B. Brown, "The Indo-Asia Pacific and the Multi-Domain Battle Concept," *Military Review: The Professional Journal of the United States Army* (September-October 2017), 14.

Jon Bott, John Gallagher, Jake Huber, and Josh Powers surmise in their article that this new concept is a much-needed change for the US Army but they provide caution to current army leaders. The authors of this article state this new lexicon of the Multi-Domain Battle Concept calls for a mental shift in operational approaches for Army leaders. They also stress that innovation and creativity should be encouraged for this new concept to feasible and successful.[22] This article provides recommendations on training for this new concept and prudent risks that leaders should accept when applying its principles. The second phase of this literature review will focus on the A2/AD the China peer adversary perspective and the ASTS.

Timothy Bonds and Joel Predd developed research findings in a RAND study highlighting the growing Chinese A2/AD capabilities and potential scenarios for conflict in the Asia-Pacific region. They state that ground based forces with their specific capabilities offer an affordable way for US allies and partners to deter or defeat aggression.[23] Figure 2 below depicts what the authors have suggested are China's core interest from a strategic standpoint and the dangers involved in with these threats. They also provide several key findings and recommendations that are aligned with the current strategy of Multi-Domain Battle/Multi-Domain Task Force. These key findings and recommendations will be discussed in detail in a later section of this research. Other research in the area of China and their A2/AD capability to counter US military advantages on the future battlefield has a bleaker outlook.

[22] Jon Bott, "Multi-Domain Battle: Tactical Implications," *Over the Horizon: Multi-Domain Operations and Strategies,* August 28, 2017, accessed October 30, 2017, https:overthehorizon.com/multi Domainbattle/.

[23] Timothy M. Bonds., *What Role can Land-Based, Multi-Domain Anti-Access/Area Denial Forces Play in Deterring or Defeating Aggression?* (Santa Monica, CA: RAND Corporation, 2017), 44.

Core Interest	Description and Threats and Dangers
"State sovereignty"	• Refers to the exercise of authority over all state assets and the rights to dignity and independence from foreign control • Threats include cyber activity that threatens China's sovereign control of its cyber domain, as well as any action by any actor that Beijing deems an affront to the dignity of its people
"National security"	• Refers to the basic security of the nation • Dangers include nuclear war, invasion, separatism, and other threats to the nation's cohesion and survival
"Territorial integrity and national reunification"	• Speaks to the exercise of the Chinese government's authority over all claimed geographic features • Threats include any action by an actor that imperils the integrity of China's borders or the government's control of those features
"China's political system and overall social stability"	• Refers to the Chinese Communist Party–led government and political system • China's leaders regard anything that endangers Chinese Communist Party control and anything that threatens to provoke unrest and instability to be a major threat
"The basic safeguards for ensuring sustainable economic and social development"	• Refers to major sea lines of communication, natural resources, markets, and other economic and financial assets needed for economic growth • Threats include piracy and other threats to Chinese access to these goods

Figure 2. China's Core Interest. Timothy M. Bonds, "*What Role can Land-Based, Multi-Domain Anti-Access/Area Denial Forces Play in Deterring or Defeating Aggression?*" (Santa Monica, CA: RAND Corporation, 2017), 45.

Angel Cruz in his monograph explains why the President Barrack Obama administration made a shift to the Pacific Theater in 2011. Cruz's analysis of China's defense budget and military capabilities leads to some eye-opening results that display China's intent for future conflicts. He also states that China's overall strategy is to disrupt or deny freedom of movement on the battlefield by creating an A2/AD environment. The author states that China learned many valuable lessons through studying US involvement in the Middle East during Operation Desert Storm. He stated that China immediately began development of strategies to counter US military strengths.[24]

[24] Angel Cruz, "The Strategic Shift to the Asia-Pacific," 25.

One capability in the realm of A2/AD that China has demonstrated proficiency is through testing of the ASAT. It demonstrated this capability in 2007 and once again in 2014 with a direct assent anti-satellite weapon. A Congressional Research Service report from 2007 suggest that China shifted its strategy in the development of this and other space weapons to counter US dominance of the space domain.[25] These tests highlighted China's capability to launch a direct assent space weapon to both lower earth and geo-stationary orbits, which threatens all US space-based assets. Many military experts have argued that China will use this type of weapon early on in a conflict with the United States to degrade capabilities, such as GPS, that are dependent on space-based assets.

One indirect or possibly direct impact of the launching of the ASAT by China in 2007 is the debris field it created. The report for Congress in 2007 analyzed that over 950 separate pieces of debris over four inches long are not in the lower earth orbit.[26] This orbit has the majority of Earth observation, remote sensing, imagery, and other vital space-based assets for the United States military and commercial companies, such as Iridium. Since the launching of this ASAT and the destruction of the Chinese satellite, there have been incidents of damaged caused by the space debris from this incident. A Brian Weeden report stated that there is actually over 3,000 pieces of debris tracked by the US military's Space Surveillance Network and that this could affect as many as 2,000 satellites flying through this debris field.[27] It is difficult to assess if this was one of China's goals for the demonstration of this capability, but it has caused much consternation for many countries' militaries and commercial space-based companies that have to attempt to maneuver their vehicles around the debris.

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[25] Shirley Kan, "China's Anti-Satellite Weapon Test," *CRS Report for Congress* (Washington, DC: April 23, 2007), 12.

[26] Ibid. Shirley Kan, "China's Anti-Satellite Weapon Test," 2.

[27] Brian Weedan, "2007 Anti-Satellite Chinese Fact Sheet," Secure World Foundation (November 23, 2010), accessed November 1, 2017, https://swfound.org/media/9550/chinese_asat_fact_sheet_updated-2012_pdf.

China has invested a great deal of time and money to counter their future adversaries' advantages in technology through the development of not just space weapons but by bolstering their organic space capabilities. Dr. Paul Torelli stresses in his report that China has developed and will continue to develop several systems in space that eliminate their dependence on US and European commercial space-based assets. He states that through 1997 China has developed several signals intelligence, remote sensing, weather, and navigational satellites.[28] They have also developed on-orbit space control satellites capable of degrading or denying various US satellites in lower earth orbits to geosynchronous orbits.

Clausewitz is renowned for his theory of the center of gravity and defines to it in his book *On War* as "the hub of all power and movement, on which everything depends and that is the point against which all our energies should be directed."[29] James C. Mulvenon and Murray Scot Tanner describe China's center of gravity in their RAND study as the PLA would initially not try to conduct a wholesale destruction of enemy forces but would instead determine a target or target set so critical that its destruction would gravely affect operations and bring about victory. Attacking an enemy's center of gravity has advantages over other types of strategies.[30] Since the publication of this article, many military experts and leaders assess that the center of gravity for China has shifted to the destruction of the US advantage in the space domain.

One realm of the A2/AD fight that China has invested in is their electronic warfare/jamming assets designed to degraded adversary's GPS and SATCOM satellites and ground based capabilities. Dave Majumdar assesses China will use non-kinetic means in the form

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[28] Paul Torelli, *Implications of the Revolution in Military Affairs (RMA) of China's Military Modernization*, National War College (Washington, DC: April 27, 1999), IV-7-IV-8.

[29] Clausewitz, *On War*, 590.

[30] James C. Mulvenon., "Chinese Responses to U.S. Military Transformation and Implications for DoD" (Washington, DC: RAND Corporation, 2006), 53.

of an electronic warfare or cyber-attack against the US SATCOM, imaging, and GPS satellites.[31] The acquisition and development of electronic warfare capabilities, specifically jamming assets, for China focuses on denying an adversary the usage of space-based capabilities designed to remove a position of advantage.

Another capability China has developed in for their A2/AD strategy is offensive cyber capabilities. Both Omaid Faizyar and Paul Martini provide examples of China's emergence as a cyber power over the last several years. Martini discusses China's yearlong cyber-attacks against the Philippines and the disruption of flights into the Vietnam Airport. Sixty-eight government websites were denied in the Philippines over a span of 11 months and several hundred flights were disrupted in Vietnam over a two-week time.[32] China is displaying its regional power in the strategic and economically important region of the Spratly Islands. Faizar states that the US Navy Seventh Fleet's recent accidents might not be an accident. He states that China has successfully tested their cyber capabilities at sea and that the most recent accident with the U.S.S. McCain could have been a test against the American fleet in Japan.[33]

Many studies have been conducted on one of China's newest technologies, the CSS-5 anti-ship ballistic missile (ASBM). This missile is called the carrier killer by missile defense experts due to its ability to strike a mobile carrier strike group while at sea.[34] China is the most active and has the most diverse ballistic missile development program in the world. The development of the CSS-5 Mod 5 plays a significant role in their greater strategy for denying

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[31] Dave Majumdar, "Russia and China have a Sneaky Way to Crush America if World War III Goes Down," *The National Interest*, September 21, 2017, accessed October 31, https://nationalist.com.

[32] Paul Martini, "Cybersecurity is Threatening America's Military Supremacy," Resilient Navigation and Timing Foundation, September 16, 2016, accessed October 31, 2017, https://rntfnd.org/2016/09/26/china-jamming-us-forces-gps/.

[33] Omaid Faizyar, "Did China Hack the Seventh Fleet?" *Real Clear Defense* (August 17, 2017), accessed October 31, 2017, https://www.realceardefense.com/articles/2017/08/21/did_china_hack_.html.

[34] NASIC Public Affairs Office, "Ballistic and Cruise Missile Threat," *Defense Intelligence Ballistic Missile Analysis Committee (*Wright-Patterson AFB, OH, 2017), 3.

their peer adversaries access to their country or territories (Figure 3). According to the 2017 Ballistic and Cruise Missile Threat Report, China also poses a credible threat to its adversaries through the recent development of its cruise missile and hypersonic platforms.[35] The PLA's Rocket Force has been renamed the Second Artillery and are in the developmental stages of the new hypersonic glide vehicles. This new technology not only presents issues for the United States Navy but for American and Coalition forces stationed on Korea, Japan, and Guam. These missiles are just one of many kinetic or lethal assets for their overall A2/AD strategy. Many experts are cautious of this new anti-ship capability because its ability to deny the United States the ability for power projection using its blue water navy and land based forces. Others feel the A2/AD threat has always been present and that the employment of such assets is much more difficult than it may seem.

Figure 3. DF-21 or CSS-5 Mod 4. Gabe Collins, "China Deploys World's First Long-Range, Land-Based 'Carrier Killer': DF-21D Anti-Ship Ballistic Missile (ASBM) Reaches Initial Operational Capability," *China Sign Post*, December 26, 2010, accessed on November 17, 2017, http/www.chinasignpost.com/2010/12/ 26/china-deploys-worlds-first-carrier-killer-ioc/.

[35] NASIC, *Ballistic and Cruise Missile Threat 2017, Defense Intelligence Ballistic Missile Analysis Committee* (Wright-Patterson AFB, OH, 2015), 66.

Dave Mujumdar's paints a more positive picture about China's newest missile technologies for the A2/AD threat for the US Navy during an interview with Admiral John Richardson. He stated the "A2/AD is sort of an aspiration; in actual execution it is much more difficult." Richardson did include in his comments that these recent trends from China do deserve a response from the United States military but these threats do not make aircraft carriers obsolete.[36] This differing of opinions on the seriousness of the threat that China creates for their peer adversaries is what Peter Berger and Thomas Luckman would term as a social construction of reality. China views its place in the social order of the world in s particular way, which makes their perception a subjective reality and others, such as Admiral Richardson, view their reality in a more objective manner.[37] The United States has recognized that China presents significant issues to their freedom of action across the domains, specifically the space domain, and has introduced new initiatives to address China's strategy for modern warfare.

One of the requirements presented to the US Army in 2011 was the implementation of the Army Space Strategy. This strategy described the Army Strategic Space Goals of integration of space-enabled capabilities in support of the land component, the ability to influence the design of space-based capabilities, and to drive joint interoperability. This strategy was the first Department of the Army document that mentioned near to long-term goals for the degraded space environment and the need for units to adapt to this type of environment. This document also depicted strategic direction and goals for Army Space for the future (Figure 4). A major pillar developed from this strategy was the creation in 2013 of the Army Space Training Strategy (ASTS).

[36] Dave Majumdar, "Russia and China have a Sneaky Way to Crush America if World War III Goes Down," 5.

[37] Peter Berger and Thomas Luckman, *The Social Construction of Reality* (Garden City, NY: Doubleday, 1966), 77.

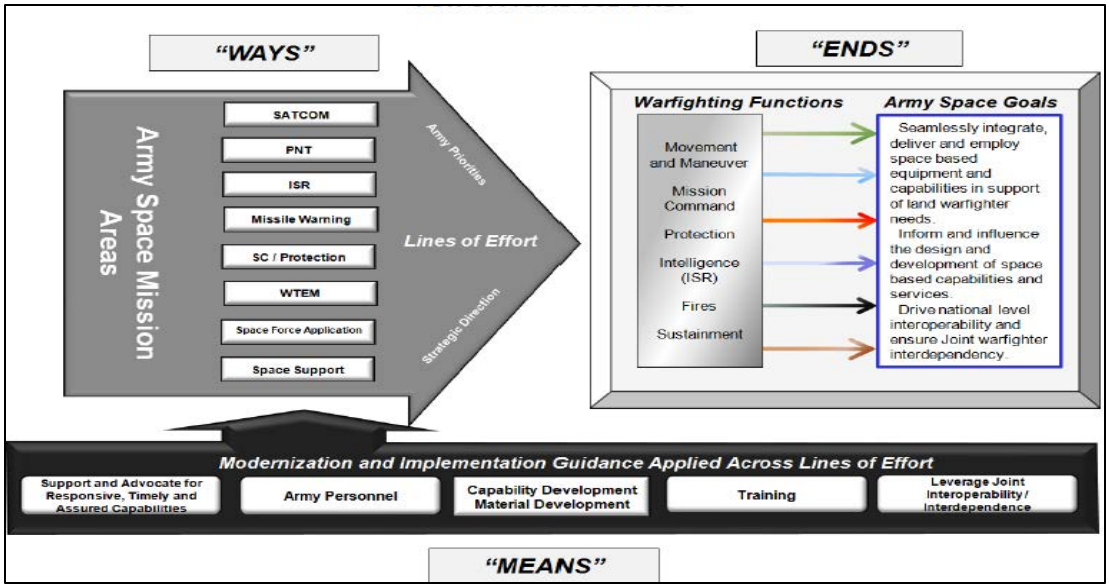

Figure 4. Army Space Operations Strategic Direction. "Army Strategic Space Plan" (Washington, DC: US Department of the Army, 2011), 11.

ASTS documents reviewed for this research is a conglomeration of analysis from CTCs, overarching strategy documents, and a Center for Army Lessons Learned Handbook (CALL). The CALL Handbook addresses the fact that the US military is reliant on space-enabled capabilities and its reliance on these capabilities has gone virtually uninterrupted in our counterinsurgency fights in both Afghanistan and Iraq. It states that this uninterrupted service has led to expectations from all leaders that these services provided by space-based assets will always be present. This handbook also provides in-depth research and analysis of the home-station and CTC training of D3SOE entailed in the ASTS. It also provides recommendations on the integration of Army Space personnel to mitigate this D3SOE or A2/AD environment and considerations for planning in the military decision making process. All of these lines of efforts for the ASTS are going to be comprehensively addressed later in this research.[38]

Another initiative gaining traction over the last few years is USASMDC's development of Nano-satellites. These satellites provide a rapid acquisition of a critical capability, such as

[38] US Department of the Army, "Handbook on Degraded, Denied, or Disrupted Space Environment," *Center for Army Lessons Learned*, October 2016, 22.

SATCOM or imagery, to the joint warfighter across all domains. USASMDC launched one of its first small satellites called Kestrel Eye on August 14, 2017 aboard the Falcon 9 Rocket headed to the International Space Station. This Nano-satellite is much smaller and cost a fraction of what many space-based satellites the US has on orbit today. Jason Cutshaw describes the benefits of this technology and the possible solutions it brings to counter the adversary's A2/AD strategy. The Kestrel Eye program hopes to demonstrate the military utility of providing rapid situational awareness directly to Army brigade combat teams.[39] Resiliency and disaggregation of satellites are another initiative that the US military has developed to address the degraded space environment.

Air Force Space Commands white paper on resiliency and disaggregation examines the need to provide resilient and affordable capabilities to preserve our operational advantage in space. The focus is on disaggregating space capabilities onto multiple platforms or systems. Disaggregation is a new approach for space systems inserted onto multiple satellites so that these valuable assets are not as vulnerable to adversaries' attempts to use both lethal and non-lethal measures to create a degraded space environment. This provides the resiliency that many US military leaders are attempting to achieve in order to counter an A2/AD future conflict.[40]

Future A2/AD and D3SOE Scenario between China and the US

The future scenario framework used here is similar to the style used by P.W. Singer and August Cole's writings deal with conflicts of peer adversaries in the future. Singer and Cole

[39] Jason B. Cutshaw, "SMDC Prepares for Upcoming Kestrel Eye Launch," *USASMDC/ARSTRAT Public Affairs*, August 1, 2017, accessed November 1, 2017, https//www.army.mil/article/191708/smdc_ prepares_for_upcoming_Keystrel_Eye_Launch.

[40] US Department of the Air Force, "Resiliency and Disaggregated Space Architectures," *Strategic Studies Quarterly* 6, no. 1 (Spring 2012), 34.

examine a fictional story set in 2035 where China decides to abandon their strategic patience by attacking perceived US advantages. Although this is a fictional account of future events, the authors use over 300 credible sources and their experience in working with military technology in developing a laudable scenario between China and the US.[41] The scenario constructed for this research will similarly rely on current doctrine from China and the US militaries, Tactics, Techniques, and Procedures used by both, testing of various systems, and new concepts from the United States designed to mitigate the current and future A2/AD and degraded space environments. This anticipation of the future is not a prediction of future conflicts, but a glimpse of what may lie ahead for the United States in a conflict with a peer adversary such as China. By examining a plausible future, we can better prepare for the actual future even if it deviates from out anticipation.

China's A2/AD-D3SOE Perspective

China has researched and adapted to the perceived US advantages in technology, specifically in the space domain, over the last several decades. They have adopted strategies to counter those advantages through the acquisition and development of such technologies as a direct assent ASAT, missiles designed to strike mobile platforms at sea, a robust cyber force, and space-based assets. Their overall strategy has transcended to an overarching plan of increased spending on defense expenditures and technological advances that have catapulted China to the status of a peer adversary for the United States. China has shifted its strategic goal over the last several years to a strong military as its arm for achieving their political aims.

[41] P.W. Singer and August Cole, *Ghost Fleet: A Novel of the Next World War* (New York: Houghton Mifflin Harcort, 2015), 167.

> To realize China's national strategic goal and implement the holistic view of national security, new requirements have been raised for innovative development of China's military strategy and the accomplishment of military missions and tasks. In response to the new requirement of safeguarding national security and development interests, China's armed forces will work harder to create a favorable strategic posture with more emphasis on the employment of military forces and means, and provide a solid security guarantee for the country's peaceful development.[42]

This stated strategy depicts a clear transition to placing the military as the lead means for achieving their goals, both regionally and globally. One pillar of this new military strategy is the creation of A2/AD capabilities across the Chinese force (See Figure 5).

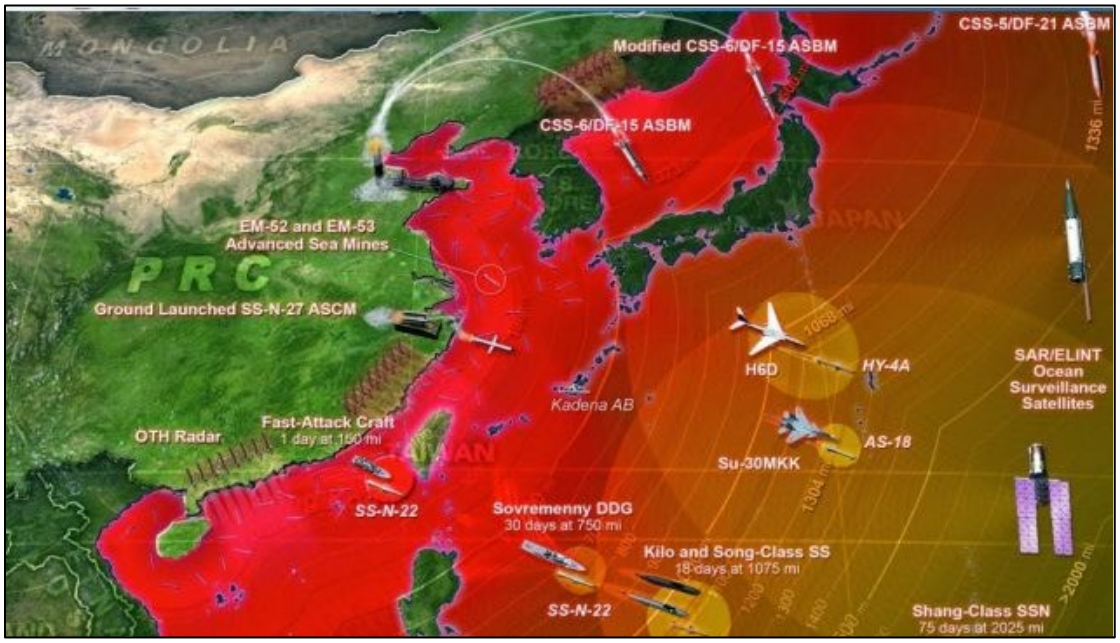

Figure 5. Example of China's A2/AD Strategy. Steven Colley and Anthony H. Cordseman, "Chinese Strategy and Military Modernization" (Washington, DC: Center for Strategic and International Studies, 2015), 77.

China continues to develop measures to counter its adversary's operational reach within the realm of the space domain, and more specifically, space-based assets. China continues to pursue advances in the air, maritime, space, cyberspace, and land domains in an overlapping manner for their military force. One aspect of this strategy that poses a strong threat to many

[42] Anthony H. Cordesman and Steven Colley, "Chinese Strategy and Military Modernization in 2015: A Comparative Analysis," 6.

countries is their counter-space strategy. Several years ago, China realized they were at a disadvantage with their reliance on the US' GPS and Europe's Galileo navigation systems. To counter this disadvantage, they developed and launched nineteen navigation system satellites into a regional configuration. This system is the Beidou Navigation System and it is due to have global reach by 2020.[43] This removes the constraint from China relying on America and Europe for its access to position, navigation, and timing needed for many of its military systems. They have also developed a robust space surveillance and imagery capability that provides means to monitor adversary's orbital and ground assets organically. Within the construct of the scenario, this would allow China freedom of action with their ground, air, and maritime assets for position and navigation purposes and timing needed for various munitions and weapons systems. With China's new independent navigation system, America will no longer have that strategic advantage.

Background Information Leading to Confrontation

Tensions in the South China Sea between China, its regional neighbors in the Pacific, and the US have been brewing since 2009. China asserted a claim in 2009 to areas in the South China Sea that include islands, reefs, banks, and other features in the area, to include the Spratly Islands, the Paracel Islands, and various boundaries in the Gulf of Tonkin.[44] (Figure 6). The main crux of the problem stems from the countries of Vietnam, the Philippines, Indonesia, and Malaysia dispute China's claim to these areas based on previous agreements between these and other countries within the Association of Southeastern Nations. The major geopolitical points of

[43] Ibid. Anthony H. Cordesman and Steven Colley, "Chinese Strategy and Military Modernization in 2015: A Comparative Analysis, 37.

[44] Tomas Sindenfaden, "How China is Winning the South China Sea" *RealClear Defense*, October 17, 2017, accessed November 30, 2017, http://www.realcleardefense.com/2017/10/19/how_china_is_is_winning_the_south_china_sea_297638.html.

contention in this dispute involves the control of major sea lines of communication in Exclusive Economic Zones (EEZ), state sovereignty rights, and control of resources like natural gas and oil. "The position of the US and most countries is that while the United Nations Convention on the Law of the Sea (UNCLOS), which established EEZs as a feature of international law, gives coastal states the right to regulate economic activities (such as fishing and oil exploration) within their EEZs. It does not give coastal states the right to regulate foreign military activities in the parts of their EEZs beyond their 12-nautical-mile territorial waters."[45] To add to the complexity of this EEZs, many of these overlap between the before mentioned countries is the South China Sea, which makes the arbitration of this dispute complex. In 2016, an arbitration tribunal ruled in the Philippines v. China case that China did not have rights to these areas under the governing laws of the United Nations Convention on the Law of the Sea (UNCLOS).[46] China ignored the ruling of the tribunal and continued to exploit this area based on historic claims that these are their rightful territories and that this matter should be resolved through bilateral agreements.

[45] Ronald O'Rourke, "Maritime Territorial and Exclusive Economic Zone (EEZ) Disputes Involving China: Issues for Congress," *Congressional Research Service*, December 1, 2017, 13.

[46] Ted L. McDorman, "The South China Sea Arbitration: The Republic of the Philippines v. The People's Republic of China," *American Society of International Law*, Volume 20, no. 4 (November, 18 2016), accessed November 17, 2017, https://www.asil.org/insights/volume/20/issue/17/south-china-sea-arbitration.

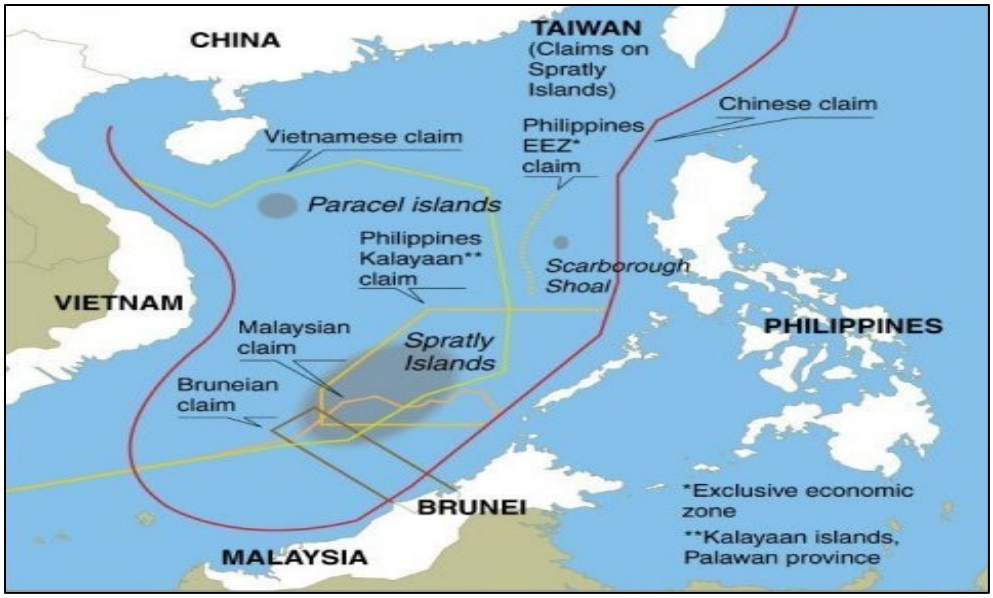

Figure 6. Disputed territorial claims in the South China Sea. Tuong Nguyen, "Uncertainty and Insecurity Generated by Claimants in the South China Sea," *Eurasia Review*, August 22, 2012, accessed November 27, 2017, http://www.eurasiareview.com/22082012-uncertainty-and-insecurity-generated-by-claimants-in-south-china-sea-oped/.

Even though the Philippines legally disputed the claims of China over these territories, their president is in negotiations with China to become potential allies. In October of 2016, President Rodrigo Duterte spoke out against the US in a speech he gave after a formal visit to Beijing. Duterte stated that he would build new alliances with China to cushion the fallout from the possible withdrawal of the US from the Philippines.[47] In the book *Great Powers and Geopolitical Change*, author Jakub Grygiel would identify the type of behavior exhibited by Duterte would as fitting within the realm of geopolitics, specifically in dealing with lines of communications and centers of resources. Grygiel viewed that lines of communications and

[47] Gil Cabacungan "Duterte seeks alliances with China and Russia," *Philippine Daily Inquirer*, September 28, 2016, accessed November 21, 2017, https://globalnation.inquirer.net/145595/duterte-seeks-alliances-with-china-and-russia.

centers of resources were invaluable in the realm of geopolitics and that the effect of the relationship of these two variables was a change in strategic value of locations and trade routes.[48]

The strategic significance behind the alliance between China and the Philippines is the possibility of America being on the outside looking in on the pivotal lines of communications in the Philippines and the region to that can afford them access to continue putting pressure on China's further expansion into these disputed territories. This type of dispute is what could lead the United States to a direct conflict with China because it threatens America's national interest and that of its allies within the Pacific region. The national interests that are threatened are the sea lines of communication that deal with the free trade that flows through that area and of the strategic location of the Philippines in relation to China.

The South China Sea area of operations encompasses about 3,500,000 million square kilometers stretching from the Malacca Straits to the Straits of Taiwan. The sea carries tremendous strategic importance; about one-third of the world's shipping sails through the seas transporting over $3 trillion in trade each year (figure 7), it contains a fishing industry crucial for the food security of millions in Southeast Asia, and huge oil reserves reported at over 17 billion gallons and gas could lie beneath the seabed.[49] Of historical significance, China argues that its claims to these disputed territories lead back to the Han Dynasty from around 200 BC.[50]

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[48] Jakub J. Grygiel, *Great Powers and Geopolitical Change* (New York, NY: Johns Hopkins University Press, 2008), 23.

[49] China Power Team, "How much trade transits the South China Sea?" *China Power*, August 2, 2017, last modified October 27, 2017, accessed November 17, 2017, https://chinapower.csis.org/much-trade-transits-south-china-sea/.

[50] Robert D. Kaplan, *Asia's Cauldron: The South China Sea and the End of a Stable Pacific*, (New York, NY: Random House, 2014), 53.

Country	% Share of World GDP	Trade Value through South China Sea (USD billions)	South China Sea Trade As % of All Trade in Goods
United States	24.5	208	5.72
China	14.8	1470	39.5
Japan	6.53	240	19.1
Germany	4.58	215	9.00
United Kingdom	3.46	124	11.8
France	3.26	83.5	7.77
India	2.99	189	30.6
Italy	2.45	70.5	8.14
Brazil	2.37	77.3	23.4
Canada	2.02	21.8	2.67

Figure 7. The Significance of South China Sea Trade. *China Power Team*, "How much trade transits the South China Sea," accessed November 27, 2017, https://chinapower.csis.org/much.

As mentioned earlier in this research, China had two successful tests of the ASAT weapon. Many defense experts assess that China's strategy is to take advantage of their strengths while at the same time exposing the weakness of its adversary.[51] During these test, China demonstrated that they have the capability to destroy satellites in Low Earth and almost reach satellites in geosynchronous orbits. China will first attempt to destroy satellites in from lower earth orbit to geosynchronous orbit exposing the US military's reliance on technology.

China will use its strategy of gaining mastery by striking first by going after the US' center of gravity, satellites in orbit.[52] The founder of Stratfor, Dr. George Friedman, stated that the center of gravity for America was its space-based assets and that an adversary like China would attempt to destroy or degrade these assets first in a conflict to blind and cripple the US military.[53] China will have the element of surprise when launching multiple ASAT weapons

[51] Brain G. Chow, "Op-ed | China's Well-Crafted Counterspace Strategy," *Space News*, June 10, 2017, accessed December 5, 2017, http://spacenews.com/op-ed-chinas-well-crafted-counterspace-strategy/.

[52] James C. Mulvenon, "Chinese Responses to U.S. Military Transformation and Implications for DoD," 57.

[53] George Friedman, *The Next 100 Years*, (New York: Doubleday, 2010), 135.

against the military and commercially owned satellite communications, such as Iridium, in this conflict in the South China Sea. The US military currently leases approximately 70% of its SATCOM from commercial satellite companies and China is fully aware of this vulnerability. "According to some Chinese analysts, the US military relies upon space for 70–80 percent of its intelligence and 80 percent of its communication."[54]

China ASAT test in 2014 also demonstrated its capabilities to reach medium earth orbit satellites, which is where the US GPS resides. China will also attempt to destroy several of these satellites in order to make navigation for US forces operating in the South China Sea degraded and disrupted timing of any GPS precision guided munition possibly being used in this conflict.

The Scenario: Confrontation with China 2030

In 2030, China attacked US satellites that belong to organizations such as the National Reconnaissance Office that provide imagery, signals, and electronic surveillance information to the US military and government. Figure 8 displays the China's counter-space capabilities and the risk these capabilities pose against US satellite assets. China has observed America's reliance and vulnerability on using technologies like these as a vital part of its operations. As discussed by the international relations theorist Joseph Nye, China is exhibiting hard power in the realm of international relations. Nye suggests that the United States should use a combination of hard power and soft power, which he calls smart power, in their strategy for foreign relations.[55] China is clearly using its military as an instrument of hard power to leverage an early advantage against the Americans in this conflict.

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[54] Harsh Vasani, "How China Is Weaponizing Outer Space: Many of China's Space Capabilities are Designed to Counter US Military Advantages," *The Diplomat*, January 17, 2017, accessed December 7, 2017, https://thediplomat.com/2017/01/how-china-is-weaponizing-outer-space/.

[55] Joseph F. Nye, *The Future of Power*, (New York, NY: Public Affairs, 2011), 211.

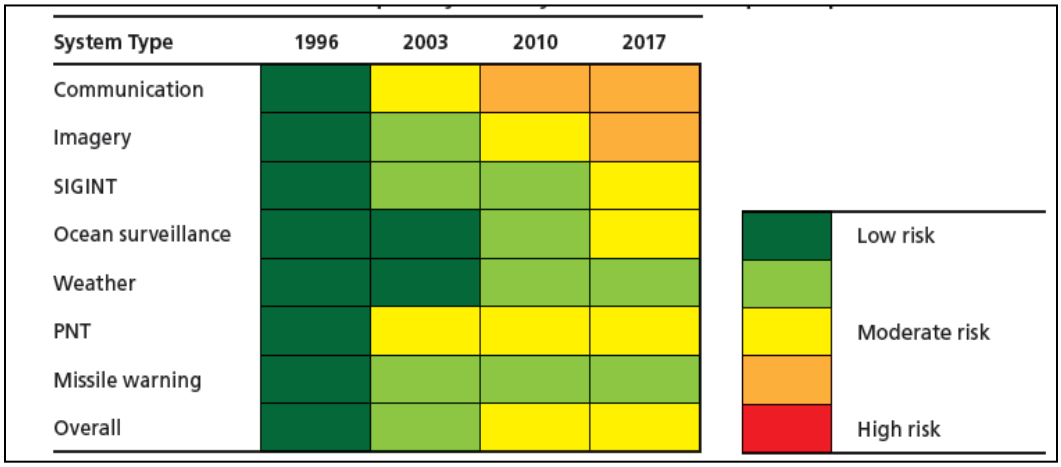

Figure 8. Estimated Risk Posed to US Space Systems by Chinese Counterspace Capabilities. Brian Eberhardt, Kenneth Kemmerly, and Paul Konyha III, "Satellite Communications," *Space Primer*, (Maxwell AFB, AL: Air University, 2009), 183.

A second order effect that China displayed during its 2007 ASAT test was the fact that this test in lower earth orbit created approximately 3,000 thousand pieces of space debris.[56] There have been two recorded incidents of space debris causing severe damage to satellites. In 1996, a French rocket body that was still in orbit from a decade earlier destroyed a French Satellite and in 2009, an inoperative Russian satellite destroyed a US Iridium satellite.[57] China will look to cause massive debris fields through the destruction of US satellites in these various orbits that could degrade, disrupt, or destroy these capabilities. This will make it challenging military and civilian satellite operators to conduct maneuvers to avoid these deadly debris fields. This second order effect could possibly destroy other valuable US and allied satellites that provide services to the Pacific region.

[56] Brain G. Chow, "Op-ed | China's Well-Crafted Counterspace Strategy."

[57] Mark Garcia, "Space Debris and Human Spacecraft," *National Aeronautics and Space Administration*, September 26, 2013, accessed December 7, 2017, https://www.nasa.gov/mission_Pages/station/news/orbital_debris.html.

Another capability that falls in line with China's counter-space strategy is by using co-orbital satellite ant-satellite systems to target US space assets. In June of 2016, China launched a spacecraft with a mission of orbital debris clean up. This spacecraft has a proximity rendezvous capability that allows it to attach itself to other objects. In this conflict of the South China Sea, China will simultaneously use this co-orbital satellite anti-satellite system to attach itself to a US imagery or communications satellite to cause chaos in space to the systems.[58] This will severely degrade GPS, SATCOM, and Intelligence gathering material for US naval ships, air force aircraft, and army assets operating in the South China Sea, Korean Peninsula, and on Japan at the start of this conflict. With selective targeting of GPS satellites with ASATs or co-orbital anti-satellite systems, China could disrupt the navigation and timing of US Navy and Army capabilities by more than fifty percent. China also uses this capability and launched a simultaneous attack with the before mentioned ASAT.

China will not hesitate to destroy these GPS satellites because of they own and maintain the Beidou Navigation System, which will be operational in 2020. This will have thirty-five satellites on orbit by 2020 and will have the ability to provide global coverage for China. China will ensure that they employ their own version of selective availability in this scenario that will continue to provide their navy and army with position, navigation, and timing needed to conduct combat operations.[59] In short, they will have access to this combat enabling technology that the US will not have during phase one and phase two of this conflict.

China has also demonstrated that it no longer needs to depend on the US and the European Union for much of its space-based products. In December 2015, China launched

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[58] Harsh Vasani, "How China Is Weaponizing Outer Space: Many of China's Space Capabilities are Designed to Counter US Military Advantages."

[59] China Science, "Beidou, China's answer to GPS, is sorely needed: Navigation and tracking for weapons, aircraft and positioning systems are too important and sensitive to put in the hands of a foreign power," *South China Morning Post*, September 23, 2017, accessed December 10, 2017, http://www.scmp.com/comment/insight-opinion/article/2112504/beidou-chinas-answer-gps-sorely-needed.

nineteen space launch vehicles that carried forty-five spacecraft that included intelligence-surveillance and reconnaissance, navigation, and scientific satellites.[60] As stated by author Mark Stokes, one of China's objectives for many years is to alleviate their dependency on foreign communications, weather, navigation, and imagery satellites.[61] Since the writing of Stokes' work, China has emerged as a dominant space power that is no longer reliant on others for space support. In this scenario, China will not hesitate to blind the United States, due in large part to the fact that they will no longer be dependent on US GPS, imagery, and SATCOM capabilities for their military. This disruption or degradation to access to several systems and products will bring on an enormous amount of friction for the US military operating in this area of operations. It will cause a disruption in intelligence, surveillance, and reconnaissance products and the use of SATCOM for mission command purposes for those Soldiers and Marines on the ground, Airmen flying in the region, and Sailors aboard ships. In short, this would blind and cripple the US military in the initial phases of combat operations and follow suit with China's strategy of denying adversaries use of space-based systems as a central part of their informational warfare.[62]

In unison with the ASAT and co-orbital satellite anti-satellite capability, China launched an attack on US satellites using lasers and laser ranging stations. Under the supervision of the China Academy of Engineering Physics department, these high-powered lasers have been in development since 1960.[63] In 2006, China demonstrated their use of one of their lasers when it fired at a US satellite, causing temporary disruption of that satellite.[64] China also has been in

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[60] Office of Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2016* (Washington, DC: April 26, 2016), 18.

[61] Mark A. Stokes, *China's Strategic Modernization: Implications for the United States*, (Carlisle Barracks: Strategic Studies Institute, September 1999), 179.

[62] Anthony H. Cordesman and Steven Colley, "Chinese Strategy and Military Modernization in 2015: A Comparative Analysis," 37.

[63] Mark A. Stokes, *China's Strategic Modernization: Implications for the United States*, 196.

[64] Francis Harris, "Beijing Secretly Fires Lasers to Disable US satellites," *Telegraph*, last modified September 26, 2006, accessed December 12, 2017, http://www.telegraph.co.uk/news/worldnews/1529864

development of a network of laser ranging stations. This network consists of five fixed stations located at space observatories in Shanghai, Changchun, Beijing, Wuhan, and Kunming. At least two mobile systems are also available. These laser-ranging stations exist for the peaceful purpose of monitoring their satellites and space debris to ensure their satellites are in no danger of being involved in a conjunction. These lasers have a small wattage capability, but during this scenario, China will have inserted higher wattage capabilities to degrade US satellites.[65]

China's efforts in the realm of laser development have put US and NATO satellites in serious danger during the escalation of this conflict. They will also employ another part of their directed energy arsenal, the high-powered microwave weapons (See figure 9). China attacked satellite down link signals, specifically those belonging to the National Reconnaissance Office, in lower earth orbit at the beginning of hostilities that provide the Intelligence Surveillance and Reconnaissance (ISR) capabilities and possibly those GPS satellites in medium earth orbit that give the US military a distinct advantage over its adversaries. These high-powered microwave weapons have been termed the superstar of direct energy weapons employed as super-jammers against a wide array of targets, to include satellite signals and ground stations.[66]

/Beijing-secretly-fires-lasers-to-disable-US-satellites.html.

[65] Eric Heginbotham, "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017," RAND Corporation, 2015, 247.

[66] Mark A. Stokes, *China's Strategic Modernization: Implications for the United States*, 201.

Figure 9. China Microwave Weapon. Jeffrey Lin and P.W. Singer, "China's new microwave weapon can disable missiles and paralyze tanks," *Popular Science*, January 26, 2017, accessed December 14, 2017, https://www.popsci.com/china-microwave-weapon-electronic-warfare.

In January of 2017, Huang Wenhua, deputy director of the Northwest Institute of Nuclear Technology, received a first prize National Science and Technology Progress Award for his research on directed energy. The awarding of this prize was for the development of a high-powered microwave weapon, given Wenhua's extensive research on the topic and accounts of his remarks at the time. The system in question tested successfully in November 2010 in northwest China.[67] Not only do these type of weapons have the potential to degrade, disrupt, or destroy satellites, they also have a unique capability to do the same to computer networks, aircraft, various missile defense radars, and missiles. This counter-space attack against the US military in the Pacific will initially have a crippling effect on various systems. GPS, various ISR capabilities, SATCOM, and radar systems potentially could see disruption or degradation by at least fifty percent in the opening phases of this South China Sea conflict.

[67] Elsa B. Kania, " The PLA's Potential Breakthrough in High-Power Microwave Weapons: Though details are scarce, recent Chinese reports hint at a major advance in HPM technology," *The Diplomat*, March 17, 2017, accessed December 14, 2017, https://thediplomat.com/2017/03/the-plas-potential-breakthrough-in-high-power-microwave-weapons/.

China's next move in this military conflict is an attack using their A2/AD capabilities that mentioned earlier in this research. During this phase of China's attack, they will deploy and use their robust jamming capabilities in the form of ground and air platforms. China will synchronize this attack with the other counter-space tactics to ensure maximum degradation or destruction caused to satellites and radars in the area. China specifically targeted GPS, SATCOM, and multiple radars in the area, which degraded the US capability to detect missiles because many air and missile defense radars will be severally disrupt during this phase of the operation.[68]

China has demonstrated in the past that they have the capability to use electronic warfare and jamming techniques to degrade communications equipment. China attacked the Joint Tactical Information Distribution System (JTIDS) in this phase of the operation. JTIDS purpose is for data communications allocation across the link 16 design, specifically those in the air and missile defense arena. Link 16 is a military tactical exchange network used by NATO for military aircraft, ships, and ground forces to exchange the tactical and operational picture in near real time (Figure 10).[69] This jamming operation severely degraded air and missile defense radars and weapon systems, such as the US Navy's Aegis missile defense weapon system and the US Army's AN/TPY-2 radars, across much of the Korean Peninsula, Japan, and on Guam. China was able to obtain the information about JTIDS through their network of spies that have been operating and stealing technology secrets for several years.[70] Jamming of this network is a critical facet of their next phase of A2/AD operations for China.

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[68] Office of Secretary of Defense, *Annual Report to Congress*, 53.

[69] US Department of the Army, "Tadil J: Introduction to Tactical Digital Information Link J and Quick Reference Guide," *Air Land Sea Application Center*, June 2000, 15.

[70] Bill Gertz, "Chinese Military Capable of Jamming U.S. Communications System: U.S. spy's secrets assist Chinese electronic warfare against U.S. military data links," *The Washington Free Beacon*, September 20, 2013, accessed December 27, 2017, freebeacon.com/national-security/chinese-military-capable-of-jamming-u-s-communications-system/.

Figure 10. Link 16 Network. US Department of the Army, "Tadil J: Introduction to Tactical Digital Information Link J and Quick Reference Guide," Air Land Sea Application Center. June 2000, 12.

China disrupted these crucial air and missile defense networks so that they could launch their missiles at US Navy and Army forces to broaden the effected A2/AD environment. China launched their CSS-5 Mod 5 or DF-21, nicknamed the carrier killer, against US Navy Carrier Strike Groups in this Spratly Island conflict to take away this advantage with its carriers off the coast of China. These long-range missiles strikes reduced a CSG ability to launch aircraft from its carriers by approximately twenty-five percent before America can counter these threats. China also has nuclear capability on its intermediate and intercontinental ballistic missiles.[71] This paper will not go in depth on China's future capability of its nuclear force; therefore, more research is required to assess their capabilities in this type of scenario.

The CSS 5 and DF-21 series missiles are a key component to China's A2/AD strategy in this hypothetical conflict with the US. The reason for this is that these variant missiles gives them the ability to deter or destroy US Navy carriers at ranges of up to 2,000 kilometers and at speeds

[71] Office of Secretary of Defense, *Annual Report to Congress*, 31.

of up to Mach 10.[72] With the Aegis radars and other land-based radars being jammed, the navy will have a difficult time acquiring and destroying these inbound missiles. Another key missile system that China deployed during this phase of the conflict is their cruise missile arsenal.

China launched a variety of cruise missiles at US Navy ships in the Pacific and at US forward bases in Korea, Japan, and Guam. Many of these locations are where hundreds of aircraft are unprotected from attacks from China ballistic and cruise missile threats.[73] What makes these variants of missiles threatening is that radars are degraded during this phase and these missiles have the flight trajectory of only about five to 10 meters from the surface. They also have the capability of the multiple independently targeted reentry vehicles and maneuverable reentry vehicles that make it difficult to acquire during the reentry portion of the missile's flight because it presents radars with maneuverable warheads and multiple targets to discriminate.[74] These capabilities are further advanced in 2030 in comparison to all data and testing available during the time of this research due to Chinas continued advancement of missile technology.

Along with cruise missiles, China's development of a hypersonic glide vehicle is complete by the time of this scenario, they will launch several of these at sea, and land-based targets simultaneously with the cruise missiles. China recently tested the DF-17, which was the first ever hypersonic glide vehicle intended for operational deployment (Figure 11). "Hypersonic gliders, by virtue of their low-altitude flight, present challenges to existing radar sensor technology enabling missile defenses. By flying at a low altitude instead of reentering from a much higher apogee on a ballistic trajectory, adversary radars would detect hypersonic glide

[72] Ballistic and Cruise Missile Threat 2017, *Defense Intelligence Ballistic Missile Analysis Committee*, 44.

[73] Eric Heginbotham, "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017," 325.

[74] Ibid, "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017," 255.

vehicles with less time for an interception to take place before the payload can reach its target."[75] Once again, the jamming and electronic warfare operations will set the stage for this new technology to be effective against US Navy ships and US Army ground forces during this phase. China will destroy or degrade about 50 percent of the US Army's air defense systems and about one-third of the CSG's capabilities once this phase is complete.

Figure 11. China Hypersonic Glide Vehicle. Ankit Panda, "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed with a Hypersonic Glide Vehicle," *The Diplomat*, December 28, 2017, accessed January 18, 2018, https://thediplomat.com/2017/12/introducing-the-df-17-chinas-newly-tested-ballistic-missile-armed-with-a-hypersonic-glide-vehicle/.

The beginning phase of this conflict in the Spratly Islands demonstrates China's strategy and doctrine to counter the perceived US advantage in the space domain.[76] The uses of ASAT weapons and counter space orbital satellites will destroy or degrade about one-third of the satellites assigned to the pacific region. This will cause a disruption in ISR, SATCOM, and other

[75] Ankit Panda, "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed with a Hypersonic Glide Vehicle," *The Diplomat*, December 28, 2017, accessed December 28, 2017, https:// Thediplomat.com/2017/12/introducting-the-df-17-chinas-newly-tested-ballastic-missile/.

[76] Anthony H. Cordesman and Steven Colley, "Chinese Strategy and Military Modernization in 2015: A Comparative Analysis, 109.

vital services that the US military has become reliant on to conduct operations in all domains. China's development in the realm of space launch capabilities by the year 2030 will allow them to disrupt satellites in medium, highly elliptical, and geostationary orbits. This will cause degradation of services like GPS, intelligence, and missile warning for the Pacific region. Again, US forces will see a disruption of approximately fifty percent during this phase of the operation. This disruption allows China to seize the initiative by taking away the US' advantage of space-based assets and at the same time, allowing them to use their own assets in the space domain.

The other aspect of their strategy and doctrine used during this phase of the conflict was the A2/AD theories and concepts. The initial phase saw China use its direct energy weapons, specifically lasers and high-powered microwave weapons, to degrade US satellites and ground-based radars. Following this operation is the use of jamming and electronic warfare capabilities that will blind ground, air, and sea-based radars and downlink satellite data. This will degrade the US capabilities to detect and engage inbound missile strikes. This operation will interfere with missile-warning systems, such as the Space Based Infrared System, that provides global and theater missile warning to all US forces.[77] China's use of short to intercontinental ballistic and cruise missiles, along with the new hypersonic glide vehicle is a challenging scenario for the US in the Pacific during this conflict.

China's overall strategy and doctrine to disrupt, deny, or destroy the US' advantage in the space domain functioned well during the initial phase of this conflict. Their preemptive strike strategy was successful in catching the US by surprise and taking away its technological advantages they believed they had in this scenario.[78] Recommendations for how the US can

[77] Eric Heginbotham, "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017," 256.

[78] Anthony H. Cordesman and Steven Colley, "Chinese Strategy and Military Modernization in 2015: A Comparative Analysis," 37.

counter China's strategy and doctrine with use of its own theories and concepts will be explored in the next section.

Recommendations/Conclusion

"The Army's space capabilities can be viewed as a dual-edged sword. Along one edge, when properly protected, they provide an unmatched and undisputed combat advantage. On the other edge, near-peer adversaries view these capabilities as vulnerabilities to be exploited. How soldiers continue to move, shoot and communicate within a denied, degraded and disrupted space operational environment (D3SOE) will, in part, determine how quickly and efficiently the Army prevails in land combat.[79]" The US military has identified the challenges that this A2/AD and degraded space environment prior to this hypothetical scenario. Research is ongoing through various organizations like the RAND Corporation and resources have been committed in the adoption of new theories and concepts like the multi-domain battle concept. There is still much work needed in order for American forces not to be hamstrung by the capabilities of peer and near-peer competitors that this scenario and research have illustrated.

The first order of business is to recognize biases that military leaders have and how they are anchored in their beliefs. One of the biggest unrecognized biases is the anchoring effect. Kahneman argues that the anchoring effect happens when people consider a value for an unknown quantity before estimating the quality.[80] Therefore, leaders must first realize the quality of the space domain before they make an assessment on its value and the method to approach this is through institutional, home-station, and CTC education and training. As mentioned earlier in this research, the US Army developed and released their space strategy in 2011 that directed efforts in the realm of providing realistic space training to various units and organizations

[79] William T. Coffey Jr, "Denied, Degraded and Disrupted," *Purview*, December 29, 2017, accessed January 18, 2018, http://purview.dodlive.mil/2017/12/29/denied-degraded-disrupted/.

[80] Daniel Kahneman, *Thinking, Fast and Slow* (New York, NY: Farrar, Straus, and Giroux, 2011), 87.

throughout the Army. Starting in 2013, USASMDC/ARSTRAT began dispatching mobile training teams to the Combined Training Center in Ft. Irwin, California. The mobile training teams were able to train 10 separate brigades during these rotations on D3SOE considerations.

A major training objective during these rotations was to degrade and deny GPS through electro-magnetic interference techniques to the rotational units for a fixed period during training. One of the common observations during this training was that most units did not recognize the importance of using mitigation techniques, such as encryption of GPS devices, prior to training. The mobile training team did observe that many of the observer/controllers were able to provide immediate feedback to units on the degraded space environment. They also observed that many units were incorporating D3SOE into their operations orders and into their overall mission success criteria.[81] One observation was that units were not identifying that they were in a degraded environment and that some units operated poorly in this type of environment. This awareness of Soldiers and leaders across the US Army is essential for future conflicts, such as the one presented in this hypothetical scenario.

The key observation made during these rotations was that the units that operated effectively in this degraded space environment were the ones that had conducted home-station training for this prior to their CTC rotation. Leaders of these organizations placed emphasis on this training objective so that the unit would be prepared to fight in a degraded GPS and space environment.[82] This type of training is vital to preparing US forces to operate effectively in a degraded space environment presented in this hypothetical scenario with China. The US must ensure that there is continued emphasis placed on both home-station training and CTC rotational unit training in order for these forces to adapt to operating in a disrupted space environment.

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[81] Joan Rouseau, "G37 HST and CTC Rotation Observations," *USASMDC/ARSTRAT Observations*, June 2017, 4.

[82] Ibid, "G37 HST and CTC Rotation Observations," 5.

Much of the space-enabled equipment that a Soldier heavily relies on will not optimally perform and this is why all levels of leadership need to be educated on this vital domain. Continued emphasis on the D3SOE and A2/AD conflicts should continue in institutional learning from various NCOES courses to the Army War College. A shared understanding needs to occur throughout the force so that the first time a Soldier experiencing this type of environment is not during a type of conflict presented here.

The new Multi-Domain Battle concept has made strides in closing the structural gaps the US Army currently has in dealing with this type of scenario. As mentioned earlier in this research, the US Army and Marine Corps released a white paper in 2016 addressing this new concept. The US Army and Air Force are in collaboration to produce a co-authored paper for release in 2018. General Perkins, the current Training and Doctrine Command commander, stated that "forces must find ways to operate as never before and that this concept layers various spheres of battle from traditional air-land battle to coordination with navy elements, space, cyber, and the human dimension."[83]

This is a key theory/concept that is materializing throughout the US Army and the joint force because it realizes that the hypothetical scenario depicted in this research is a feasible forecast for the future. GEN Milley and many senior military leaders appreciate the importance of the space domain and that peer competitors like China have meticulously observed our Air/Land Battle Doctrine and counter-insurgency operations over the last twenty-eight years. This is what Dietrich Dorner would address in his book *The Logic of Failure* as an emergent operational environment addressed as a complex system, not as if it were a bundle of unrelated individual

[83] Todd South, "New in 2018: Army Pushes Forward on Multidomain Battle, New Way to Fight," *Army Times*, December 31, 2017, accessed January 18, 2018, https://www.armytimes.com/news/your-army/2017/12/31/new-in-2018-army-pushes-forward-on-multidomain-battle-new-way-to-fight/

systems.[84] MDB is addressing the complex, emergent system that Dietrich describes for the US' future operational environment.

One key component for the MDB concept for the space domain is that the force is not sufficiently trained, organized, equipped, or postured to deal with a peer adversary mentioned in this research. Another component that this concept is addressing is the lack of identification by senior leaders mentioned earlier in this research in regards to fighting in a degraded space environment. The MDB white paper addresses this by stating that headquarters and subordinate units must be capable of operating in a degraded operational environment. The paper further states that the US Army must reduce vulnerabilities through more redundant and survivable systems in such areas as PNT. This concept is a step in the right direction in addressing the military problem of effectively fighting in a degraded space environment. The exercises in the PACOM region over the next few years will provide the necessary feedback to assess this concepts feasibility in dealing with this threat.[85] Both PACOM and the Training and Doctrine Command will be collecting all relevant data to assess this concept in fiscal years 2018 and 2019 for future integration into doctrine and other exercises.

A major effort emerging from the MDB concept is the proposed creation of the Multi-Domain Task Force. A critical component of this task force's outcome is to ensure that leaders have an understanding and appreciation for the right space capabilities matched with the appropriate army space professionals. Integration of both offensive and defensive space capabilities coordinated with the employment of cross-domain fires will enable the US Army and joint force to achieve desired effects. If space-based capabilities are integrated into this task force,

[84] Dietrich Dorner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations* (Cambridge, MA: Perseus Books, 1989), 88.

[85] Mike Redman, "Multi-Domain Battle: Combined Arms for the 21st Century," 5.

the A2/AD and anti-space effects that an adversary like China will employ, should be neutralized, or at least degraded.[86]

The composition of people within this task force is critical to being for forward deployment to provide coordinated effects on the battlefield. Space professionals are a critical component of this task force but other specialties should comprise this team. This task force should include members of the cyberspace and electronic warfare communities so that non-lethal fires can exploit the greatest advantage possible against adversaries. One key issue that the MDFT will address is the authorities' aspect to ensure that these effects are conducted in time and space with synchronization of the other domains. These members will play a critical role in the US military being able to extend its operational reach by countering the adversaries attempts to degrade the space and other domains.[87]

The last integral piece to this task force deals with the appropriate equipment disposition. This task force should employ all available defensive and offensive space capabilities and capacities that are available. This will take appropriations at the policy and strategic levels to procure the requisite amount of equipment to complete such missions. This is something that cannot be done overnight, but can be planned and appropriated before this hypothetical conflict in 2030 arises. The last piece of this recommendations and conclusion section are focused on the need for more resilient technology, such Nano-satellites.

As mentioned earlier in this research, a new type of technology that it making it more difficult for adversaries to target are Nano-satellites. USASMDC launched a Nano-satellite called

[86] Todd South, "4-star: Multi-domain battle will fundamentally change how the Army, other services fight," *Army Times*, October 8, 2017, accessed January 18, 2018, https://www.armytimes.com/ News/ your-army/2017/10/08/4-star-multi-domain-battle-will-fundamentally-change-how-the-army-other-services-fight/.

[87] Ibid, "4-star: Multi-domain battle will fundamentally change how the Army, other services fight."

Kestrel Eye to the International Space Station last summer and activated for use in October of 2017. Kestrel Eye will enhance situational awareness of the US Army units on the ground by providing satellite imagery without the need for conventional, continental US-based relays.[88] This will shorten time on the ground that Soldiers can receive imagery and be able to provide commanders on the ground situational understanding of their operational environment. It also cost a significant amount less than the large satellites currently used now and it provides a much smaller footprint for adversaries to attempt to degrade its operations. Another major advantage is since it is smaller; its development and ability to launch is much quicker in order to replace destroyed satellites.[89]

Many have voiced concerns over cost and reliability of this new, smaller system. Kestrel Eye cost 1.3 million dollars to produce and launch into space and it only weights about forty pounds. In comparison, the Space Based Infrared System cost 1.5 billion dollars to make and weighs about 10,000 pounds. Kestrel Eye also produces about the same type of performance that a larger imagery satellite produces, which is a 1.5-meter ground sample distance for each image. This system cost less while producing about the same product of a more expensive and larger satellite.

This type of technology is in line with comments that the USSTRACOM Commander, Gen Hyten, made in December of 2017. He stated, “The US needs assured access to space. We need to move quickly, we need to accelerate acquisition, [we] need to innovate and prototype new

[88] Jason B. Cutshaw, “Army Deploys Kestrel Eye Satellite,” *USASMDC/ARSTRAT Public Affairs* (October 25, 2017), accessed January 23, 2018, https://www.army.mil/article/195548/army_deploys_kestre_eye.

[89] John London, “SMDC Space Initiatives,” *USASMDC/ARSTRAT Space and Strategic Systems Directorate*, June 2015 7.

systems faster."[90] He also said that the reason behind his comments were because Russia and China have been watching the US dependence on space since Desert Storm.

In another article, Hyten expresses that he will not support large satellites that present big, juicy targets to the enemy. He states, "One problem that needs fixing is how the Pentagon procures satellites. The Air Force spends too much money and time developing large satellites that make attractive targets."[91] These views seem to be in concert with USASMDC's Nano-satellite efforts for creating smaller, reliable platforms that make it more difficult for an adversary to deny, degrade, or destroy. In addition, the National Reconnaissance Office and the Unites States Air Force have adopted a new strategy called the space enterprise vision that focuses on defense of space-based assets through the acquisition of these smaller satellites.

This research's goal was to develop a feasible and acceptable solution to the original hypothesis. First, the concept of Multi-Domain Battle and the future creation of the Multi-Domain Task Force will ensure that the US Army creates opportunities for the land component to exploit against peer adversaries, and it will ensure that these forces can effectively operate in an Anti-Access/Area Denial environment (A2/AD). Secondly, the mandated Army Space Strategy and the creation of the ASTS will educate and train Army forces to operate in a degraded space environment. The question that was proposed was can the US Army effectively operate in a degraded space environment?

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[90] John E. Hyten, "U.S. Must Move Faster or Risk Losing Lead in Space," *DoD News, Defense Media Activity*, December 2, 2017, accessed December 18, 2017, https://www/defense.gov/News/Article/1386361/us-must-move-faster-or-risk-losing-lead-in-space/.

[91] Sandra Erwin, "STRATCOM Chief Hyten: I will not support buying big satellites that make juicy targets," *Space News*, November 17, 2017, accessed January 18, 2018, http://spacenews.com/stracom-Chief-hyten-i-will-not-support-buying-big-satellites-that-make-juicy-targets/.

Since both of the hypothesis of the utility of the Multi-Domain Battle concept and the ASTS are future oriented, it is hard to determine today. It does point to the fact the issues of a degraded space environment and Anti-Access\Area Denied capabilities of peer adversaries have been evaluated and are being addresses appropriately. The MDB concept and the creation of the MDTF is a much-needed change in an emergent operational environment. This concept will ensure that the US Army and joint force will be properly trained, equipped, and postured to deal with the conflicts presented in this strategy.

The Army Training Strategy is gaining momentum with the maneuver force in the US Army as members of this training team continue to conduct training at both home-station and at CTCs. A continued emphasis from strategic down to tactical level leaders is a practical solution to developing situational understanding across the force in regards to degraded space operations. More realistic and demanding training on all facets of space-based capabilities ensures the US maintains its initiative on the battlefield. The space domain is a key enabler to the US achieving success in any conflict.

Another document that provides a promising outlook for the question of fighting in a degraded space environment is the National Security Strategy from December of 2017. This strategy highlights the importance of the space domain by proclaiming it is a priority domain. This document also provides evidence that there is a shift for the military from the counter-insurgency fight to peer adversaries A2/AD capabilities. This refocusing of efforts to peer adversaries like China will ensure that the US is postured more adequately for the scenario studied in this research.[92]

The question remains if the US Army can effectively fight in a degraded space environment. The evidence provided by this research would suggest that the current state of readiness in regards to a degraded space environment for the US Army is no. There is still much

[92] *National Security Strategy of the United States of America*, (Washington, DC: December 2017), 14.

more education at the institutional level and training at the tactical and operational levels that needs to occur. Efforts are ongoing through the ASTS to ensure more units are receiving this training. The MDB concept is currently under evaluation at various exercises and the MDTF creation is to facilitate change in mindset and organizations for the future fight. Only time will tell if the US Army can effectively fight in a degraded space environment, but all signs point to a resounding yes for future conflicts.

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