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SPACE COMMAND AND CONTROL IN A CONTESTED ENVIRONMENT: IS USSPACECOM GETTING IT RIGHT?

By

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ABSTRACT

The space command and control structures of USSPACECOM were originally designed for operations in an uncontested environment, but development by the United States' potential adversaries have transformed the space domain into a contested environment. Therefore, USSPACECOM must seriously consider changing the command and control structures to deal with this changed environment. This research paper utilized the scenario planning methodology to examine how well the current command and control structures would operate in a contested environment. Four fictional, but plausible scenarios are developed to illustrate how these structures would operate in conflicts occurring in the year 2029. Through these scenarios, a rather serious picture of inefficiency emerges on how effective the current command and control structures would be in a contested environment. Though not leading to outright disaster on its own in the scenarios, the command and control structures of USSPACECOM were almost always a hindrance to space forces supporting the joint force, rather than an enhancing function. From these scenarios, four recommendations are developed for decision makers to consider in the hope of improving command and control structures prior to any of the situations outlined in the aforementioned scenarios can occur.

INTRODUCTION

In 2002 the United States stood down United States Space Command (USSPACECOM) and transferred the warfighting functions of its military space mission to United States Strategic Command (USSTRATCOM). Over the next 16 years command and control of military space assets was one of the many responsibilities under the umbrella of USSTRATCOM until the 2018 re-establishment of USSPACECOM.[1] During this period of time, the United States' adversaries continued to grow and develop their own space capabilities, effectively closing the capability gap between them and the United States. This, plus those adversaries understanding of the advantages gained by space, has led to a rapidly evolving domain. Without a dedicated focus, the military struggled to handle the challenges of this evolving domain.[2] Though the best efforts of USSTRATCOM led to the development of the Joint Force Component Command for Space (JFCC Space) and the Joint Space Operations Center (JSPOC) to try to address these challenges, the lack of true focus on the space domain has kept the efforts from making the potentially larger changes needed to keep paces with those challenges.[3] Fortunately, the reactivation of USSPACECOM should help to meet those challenges.

A number of challenges are facing USSPACECOM as it has been re-established, such as the threat of adversaries contesting the space environment and the rapid increases in space activities that are causing congestion.[4] Not only does it have to assume command and control of an entire, brand new warfighting domain, but it has to do so with command and control structures that were designed for a benign environment, without the threat of adversary action impacting friendly operations. This is happening just as that domain is one that is becoming more and more contested,[5] as our adversaries see potential weaknesses in our space asset's ability to operate in a contested domain. They seek to reduce our advantages, many of which are provided by space

assets that are now seen as vulnerable. While dealing with nearly two decades of not having a combatant command focused on fighting a possible war in space,[6] USSPACECOM must adapt to the reality of a contested operating environment and still work to provide access to space, which is vital to the security of the United States and its allies.[7]

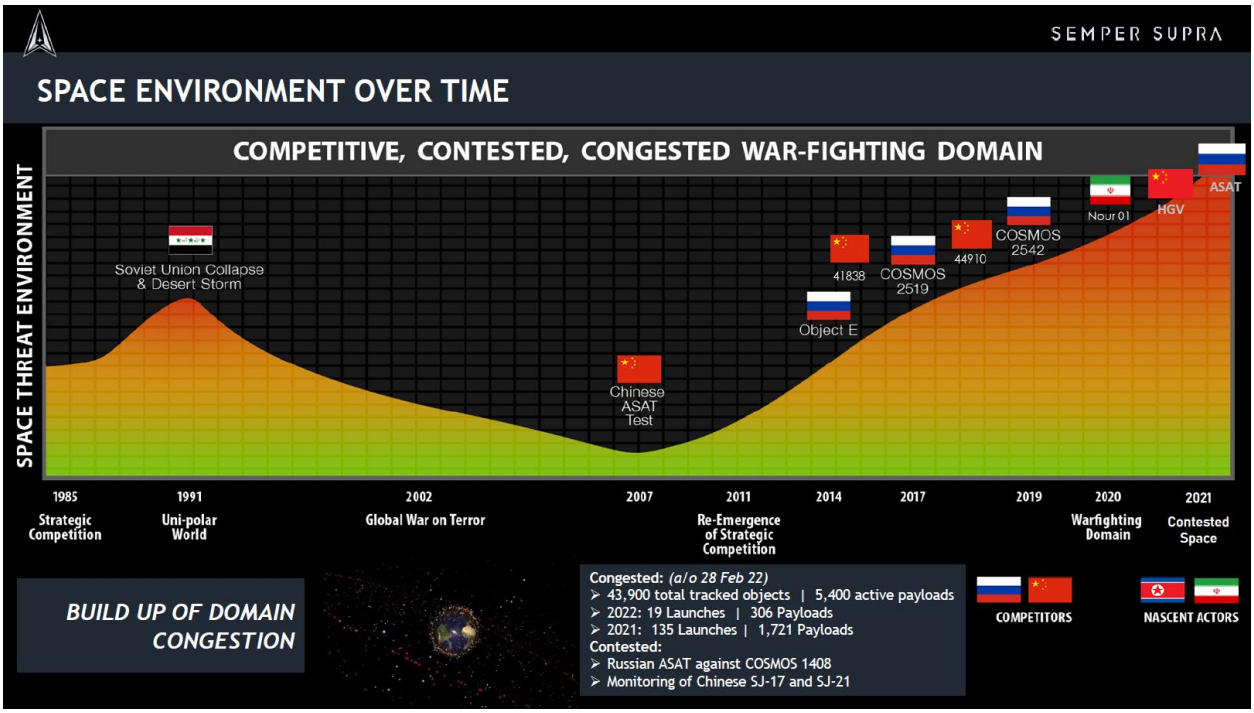

Figure 1: Space Environment Over Time[8]

In the profession of space operations, an important question must be addressed, and this question is the topic of this paper: "How can the command and control structures of the space domain be improved for operating in a contested environment?" This paper will employ the scenario planning framework to investigate the command and control structures of the space domain and determine how effective they are in a contested environment. First, it will lay some foundational knowledge, by explaining the current doctrine for warfighting within the space domain, how current USSPACECOM command and control structures function, and the importance of the space domain to the joint warfighter. Next, this paper will examine the changes

within the space domain which are driving this question, specifically how the United States' potential adversaries are making the domain contested. These driving factors will then help to inform four different scenarios to help to evaluate the effectiveness of the current command and control structures of USSPACECOM. Finally, this paper will analyze the effectiveness of the command and control structures, based on how effectively the structures support the core responsibilities of United States space forces, and offer recommendations on what can be done to improve those structures to better operate in a contested domain.

This paper will make the argument that the current command and control structures are insufficient to meet the demands of a contested environment. The changes that have been made to the capabilities of potential adversaries, as well the expanded capabilities of the commercial sector have significantly changed the space domain. Without a corresponding shift in the command and control structures which USSPACECOM utilizes to maintain space operations to support joint operations, the United States will lose out on a critical force multiplying benefit,[9] and be poorly positioned for success in any potential conflicts with its potential adversaries going forward.

BACKGROUND

Space Force Responsibilities

Space has only recently become recognized as its own warfighting domain, complete with its own military branch dedicated to organizing, training, and equipping forces to fight within that domain in the United States Space Force (USSF).[10] Though still brand new, the USSF has already made considerable strides in developing doctrine for warfighting in the space domain, with a Capstone doctrine document, along with five of their six Keystone documents already published and being utilized by the Guardians of the USSF.[11] These documents will help to establish what the USSF, as the United States' branch focused on the space domain, are preparing forces for as

they present them to USSPACECOM, which is the United States' space domain warfighting organization. The responsibilities and competencies outlined in these documents will be critical in understanding what United States Space Forces will attempt to accomplish during a potential conflict.

There are three cornerstone responsibilities of military space forces, preserving freedom of action in space, enabling joint lethality and effectiveness, and providing independent options to achieve desired strategic effects.[12]

The United States' ability to project and employ national power is reliant on freedom of action in space, which is why that is one of the cornerstone responsibilities.[13] Taking some cues from the United States Air Force, the USSF has described degrees of advantage in preserving freedom of action, specifically space parity, superiority, and supremacy. Space parity describes a condition where no force has an advantage over the other. Space superiority is a condition where one side has a significant advantage which allows it to conduct operations without prohibitive interference. Finally, space supremacy implies the ability of one side to conduct operations with impunity while denying their adversary freedom of action.[14] USSF doctrine expects the employment of military space forces to preserve the appropriate one of these three conditions to enable the freedom of action in space.

Next, many parts of joint lethality and effectiveness are reliant on space capabilities to be effective and reach the desired location, which leads to the second responsibility of enabling joint lethality and effectiveness. Much of the first responsibility of ensuring freedom of action in space will enable the second responsibility, but the USSF wants its Guardians to focus on joint warfighting from an early point to help enable those capabilities, as well as helping to educate the wider joint force to be more space smart.[15]

The final core responsibility of military space forces is to provide independent options in, from, and to space. This responsibility is one of the key areas that have necessitated an independent Space Force and USSPACECOM as an independent combatant command. As the space domain has gained more recognition as a warfighting domain that is no longer a sanctuary from attack,[16] the potential of it to be more than just a supporter of warfare in other domains has increased.[17] Space operations are now recognized to provide capabilities that can provide options to national leadership on their own merit, in addition to their merit in supporting other domains, which is the more traditional view of space operations. These effects can be coercive or collaborative and is a key responsibility for military space forces.[18]

Space Force Core Competencies

The USSF has identified several core competencies that military space forces must maintain to achieve the accomplishment of the cornerstone responsibilities of military space forces. These competencies are space security, combat power projection, space mobility and logistics (SML), information mobility, and space domain awareness (SDA).[19]

Space security looks to protect United States' prosperity and economic security through the peaceful use of space. It works to deter potential interruptions of the peaceful use of space via presence missions that are designed to deter adversaries and reassure United States' partners that the military is positioned to monitor and protect allied interests.[20]

Combat power projection works to ensure the United States and its allies maintain freedom of action in space, and if necessary, works to deny adversaries their own freedom of action in space. This is accomplished by defensive operations to protect friendly space capabilities and offensive operations which work to degrade adversary capabilities.[21] These operations may be multi-domain, as space system architecture has three separate parts, the space segment, the

terrestrial segment, and the link segment, each of which is vital to using space capabilities. If degradation of any of those segments occurs, degradation of the entire space capability will follow, and only the space segment is primarily affected by actions in the space domain.[22]

SML focuses on both access to space in the form of the launch capability to place assets into or move through the space domain as well as sustainment of assets already on orbit. Like much of the space domain, launch has historically been an uncontested effort which can move at a slow pace to meet the needs of space operations, while on-orbit sustainment has not been utilized by the military historically, though there have been demonstrations in the commercial sector. Space forces will have to be prepared for potential contesting of launch capabilities, as well shifting to utilize on-orbit sustainment to truly fulfill the core responsibilities of space forces.[23]

Information mobility covers the collection and transportation of data across the space domain, including secure strategic communication, point-to-point and broadcast communications, position, navigation, and timing signals, missile warning, and intelligence, surveillance, and reconnaissance. Many of these capabilities are key to enabling joint warfighter lethality and protecting the joint warfighter, as well as supplying options to friendly forces around the world. Many remote areas of the world can only communicate with other parts of the world via space-based communications provided by the information mobility capability.[24]

The final core competency of space forces is SDA. SDA encompasses the identification, understanding, and characterization of any part of the space domain which can affect operations.[25] This can include space weather, adversary or friendly actions with their spacecraft, debris left in space, effects within the electromagnetic spectrum that could impact the link segment of space operations, and a host of other factors. This creates a challenge for space forces, as there is simply too much data to always have perfect SDA.[26] Despite this, SDA is critical to ensuring that space

forces are able to make the right decision at the right time to successful fulfill their operations, and all of the core responsibilities of space forces.[27]

USSPACECOM Command and Control

With the reestablishment of USSPACECOM in 2019, the responsibility for warfighting in the space domain, and commanding and controlling space assets has moved under the command of the commander, USSPACECOM (CDRUSSPACECOM). CDRUSSPACECOM exercises combatant command over space forces assigned to USSPACECOM.[28] Combatant command is "the authority…to perform those functions of command over assigned forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction over all aspects of military operations, joint training, and logistics necessary to accomplish the missions assigned to the command."[29] With that authority, CDRUSSPACECOM is able to ensure the availability of space capabilities to the joint force to ensure mission accomplishment. CDRUSSPACECOM typically will delegate tactical control (TACON) of space units to the Combined Forces Space Component Commander (CFSCC), who in turn utilizes the Combined Space Operations Center (CSPOC) to conduct planning and assessment of space operations on their behalf, facilitates coordination and support with theater combatant commands, conducts day-to-day space operations and exercises command and control (C2) of space forces and operations.[30]

In acting for the CFSCC, the CSPOC utilizes the Combined Space Tasking Order (CSTO) and special instructions (SPINS) to direct space forces to accomplish tasks to meet joint force operational needs and synchronize space operations with other joint missions. The development of this order is a planning cycle that typically takes 30 days to produce but the CSPOC can accelerate CSTO production in periods of conflict if needed. The CSTO is the primary tasking tool

for space operations execution, while the SPINS provide any additional guidance the CSPOC determines that the tasked units need to know.[31]

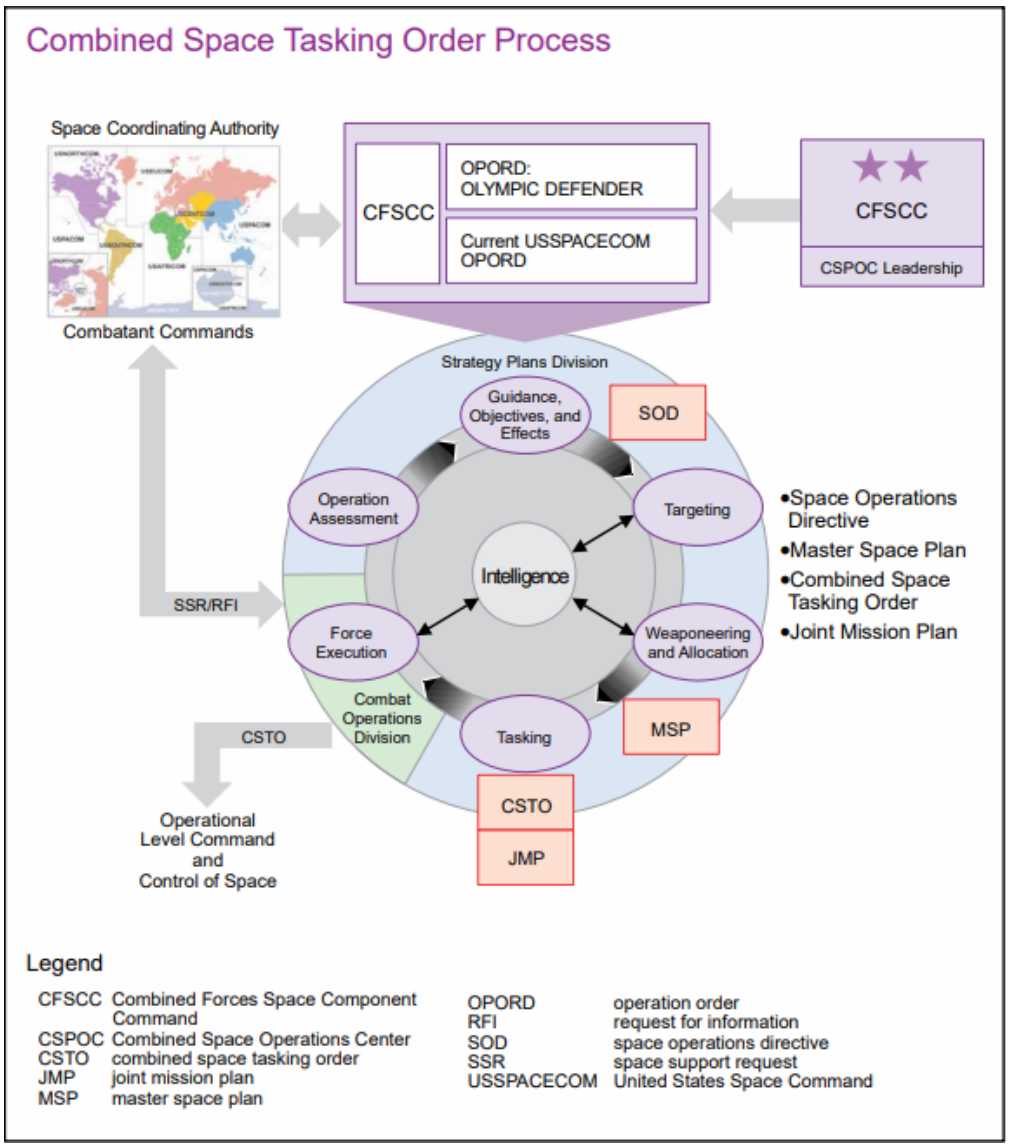

Figure 2: Combined Space Tasking Order Process[32]

The CSPOC develops the CSTO and SPINS by following the CSTO process. The strategy plans division (SPD) of the CSPOC receives guidance, objectives, and the CFSCC's desired effects and utilizes this to develop the space operations directive (SOD). From the SOD, the SPD works to develop targets and allocate space assets to service those targets which results in the development of the master space plan (MSP). From the MSP, SOD develops specific taskings for

units and creates the CSTO. SOD then sends the CSTO to the combat operations division (COD) of the CSPOC. COD distributes the CSTO to the operational units for execution, which then execute the taskings in the CSTO. Units execute the specified tasks of the CSTO as written, with any deviations from the CSTO requiring approval from CSPOC.[33]

In addition to the control exercised by the CFSCC through the CSPOC, space operations are coordinated with different theater commanders who utilize space coordinating authority (SCA) to ensure proper space support is provided to the area of responsibility.[34] A commander who has been given SCA will work to determine space requirements for the joint force, and then reach back to the CSPOC with space support requests (SSRs) and/or requests for information (RFI) that the CSPOC can answer.[35] The CSPOC's COD will work through all received SSRs and RFIs and work to determine which can be supported by the available space forces. If it can be supported, the COD will task the appropriate unit with providing the required support, either through tasking the SSR to the unit with specific guidance or passing on the RFI to receive the required information.[36]

The CSTO and SPINS methodology follows the United States Air Force (USAF) command and control tenet of centralized control and decentralized execution.[37] This is a legacy structure from the USAF's time operating the space forces of the United States and has proven effective in supporting the joint force while the space domain has been un-contested.[38]

Importance of Space Capabilities

During the 2019 Air Force Association Symposium, the first commander of USSPACECOM, General Jay Raymond made the following remark that helps to demonstrate the criticality of the Space domain: "…since 1991, largely since the First Gulf War, Desert Storm, our Air Force has been focused on integrating space into everything that we do, and there's nothing

that any of you do in any of your jobs—there's nothing that a joint force does that doesn't do it with—better because space is enabling it. Nothing. Whether it's humanitarian assistance disaster relief or whether it's combat, space is part of that operation."[39] This criticality not only applies to the joint warfighter, but also to the current way of life in the United States.

Simply put, space operations enable the joint force to conduct operations. The unique characteristics of space allow a global perspective for the joint force, as well as providing worldwide coverage for communications and surveillance that would be impossible without space-based capabilities.[40] In addition to this coverage, space operations provide the ability to respond more rapidly than terrestrial capabilities to commander's requirements, service multiple users simultaneously, and provide fast, far reaching, and persistence coverage for the joint force.[41]

There are several supplied capabilities to the joint force that help to enhance its capability. One capability is space control, which ensures allied freedom of action in space.[42] Another capability is position, navigation, and timing (PNT), which utilize space based global navigation satellite systems (GNSS) such as the Global Positioning System (GPS) to provide extremely accurate location and timing information to the joint force for operational utilization.[43] Space based sensors also provide intelligence, surveillance, and reconnaissance (ISR) capabilities to the joint force, and due to space's unique overflight characteristic, these sensors provide the only ISR for certain areas of the world.[44] Satellite communications provide a robust capability for beyond line of sight (LOS) communication that helps national and strategic leadership maintain situational awareness around the globe.[45] Finally, environmental monitoring from space helps to inform the joint force on both terrestrial environmental conditions to assist with mission planning and also space environmental conditions to ensure space capabilities are protected from the potential impacts of that weather.[46]

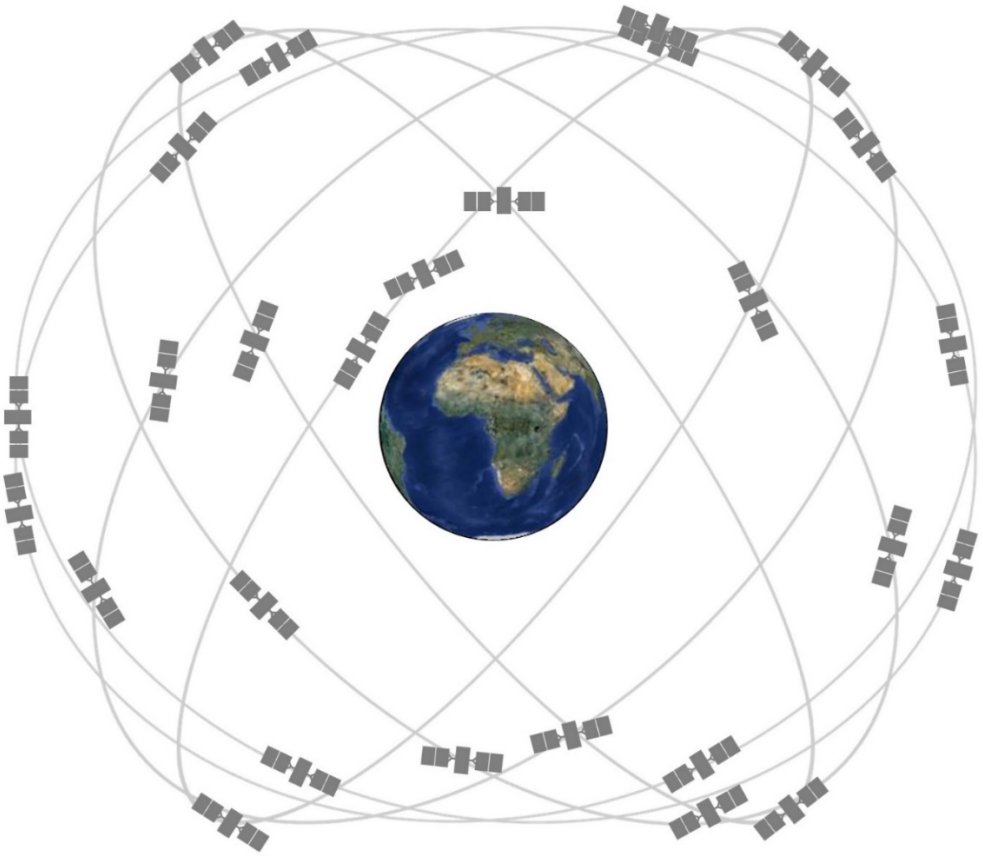

Figure 3: GPS Constellation[47]

In addition to the many capabilities provided to the joint force by military space capabilities, there are several commercial applications that capabilities originally designed for, and still operated by, the military provide. The most well know is the Global Positioning System (GPS). GPS is a United States owned and operated satellite constellation which provides users with PNT capabilities around the world.[48] The commercial applications of GPS are extensive, ranging from providing directions to drivers, to agricultural applications, providing precise timing synchronization for major communication networks, financial markets, and banking systems to enabling search and rescue efforts to more quickly locate and assist those in need.[49] Many people across the world rely on GPS, and interruptions to this capability would have far reaching repercussions beyond just the military's loss of capability.

In addition to the capabilities provided by the military, there are thousands of commercial satellites in orbit that provide numerous capabilities to the world. These satellites range from the small internet supplying satellites of the Starlink megaconstellation,[50] to the massive BlueWalker 3 satellite that provides service for satellite phones across the globe.[51] The joint force would need to protect these satellites and their capabilities during any conflict within the space domain. These capabilities include commercial satellite communications (SATCOM), and remote sensing and environmental monitoring capabilities.[52] SATCOM supplies satellite television and radio broadcasts to almost any point on the planet, as well as wideband and narrowband communications capabilities to private customers, organizations and even governments around the world.[53] Remote Sensing provides different types of imagery of the earth,[54] which can help with the environmental monitoring applications, providing data for terrestrial weather applications, including weather forecasts.[55] These capabilities provide key capabilities to the commercial sector that would be next to impossible to replicate if they we degraded or destroyed, and they can even augment military capabilities,[56] which makes them potential targets for any conflict, and something that must be protected.

DRIVING FORCES

Now that this paper has surveyed the background on the responsibilities of military space forces, how USSPACECOM commands and controls space forces, and the importance of space capabilities, it will now address the driving forces that are prompting the research question this paper plans to answer. Over the last several years, there has been a buildup in space warfare capability by several powers, such as China, Russia, Iran, and North Korea, throughout the world.[57]

Space warfare will likely be carried out using various counter space capabilities. Broadly speaking, these capabilities fit into two different categories, kinetic and non-kinetic capabilities.

Kinetic capabilities effect satellites or ground stations physically, typically through a strike directly on the asset, or a detonation near enough to the asset to effect it. These counter space capabilities tend to cause irreversible effects upon their targets and are extremely attributable to the entity that launched the attack. Due to this, no county has used these sorts of capabilities against another, and it would constitute a serious escalation if used. Non-kinetic capabilities range from lasers and microwave weapons that can interrupt a satellite's operations,[58] to electromagnetic spectrum attacks that work to interrupt the link segment of space capabilities,[59] to cyber-attacks to interrupt data and services provided by satellites.[60]

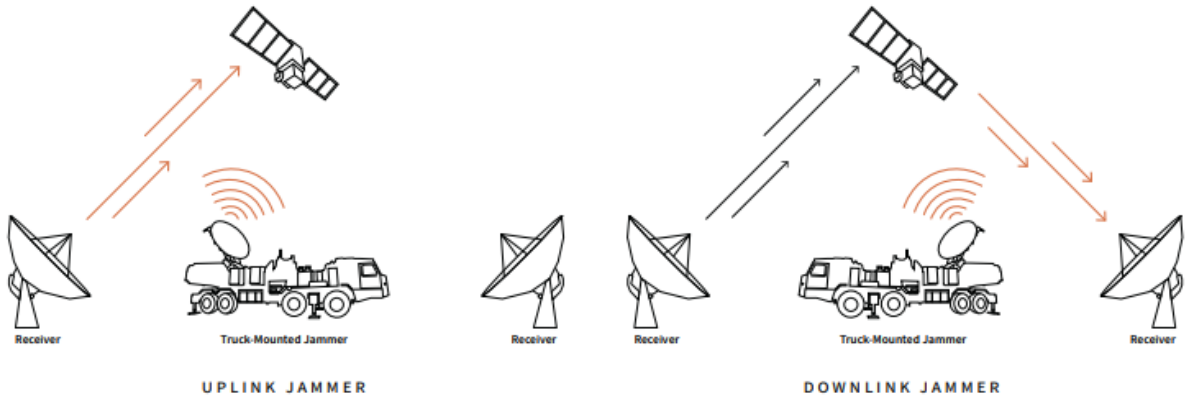

Figure 4: Uplink & Downlink Jammers[61]

Chinese Counter Space Capabilities

"In particular, China and Russia present the greatest strategic threat due to their development, testing, and deployment of counterspace capabilities and their associated military doctrine for employment in conflict extending to space. China and Russia each have weaponized space as a means to reduce U.S. and allied military effectiveness and challenge our freedom of operation in space."[62] The last several National Security Strategies, as well as the productions developed from those documents, such as the National Defense Space Strategy quoted here, have identified China as the pacing challenge of the United States across all domains, and especially in

the space domain.[63] This has borne out in the counter-space capabilities that they have developed over the last several years.

China has been developing a wide range of counter space capabilities, including the full range of both kinetic and non-kinetic counter space capabilities.

They have tested directed ascent kinetic kill vehicles,[64] also known as direct ascent anti-satellite (DA-ASAT) weapons, which launch directly from earth on a trajectory to strike a satellite in orbit.[65] China has conducted numerous tests of these weapons, most famously in 2007 when they destroyed one of their own weather satellites in a demonstration launch that created thousands of pieces of debris in orbit and causing an exponential growth in the congestion of the space domain.[66] Their testing program has become more responsible since then, with seven observed tests creating little to no long-term debris fields,[67] while still demonstrating China's ability to utilize DA-ASATs against any of their potential adversaries. These capabilities have so far only been shown to effect satellites in low earth orbit (LEO) but have a great potential for destruction within that orbit.[68]

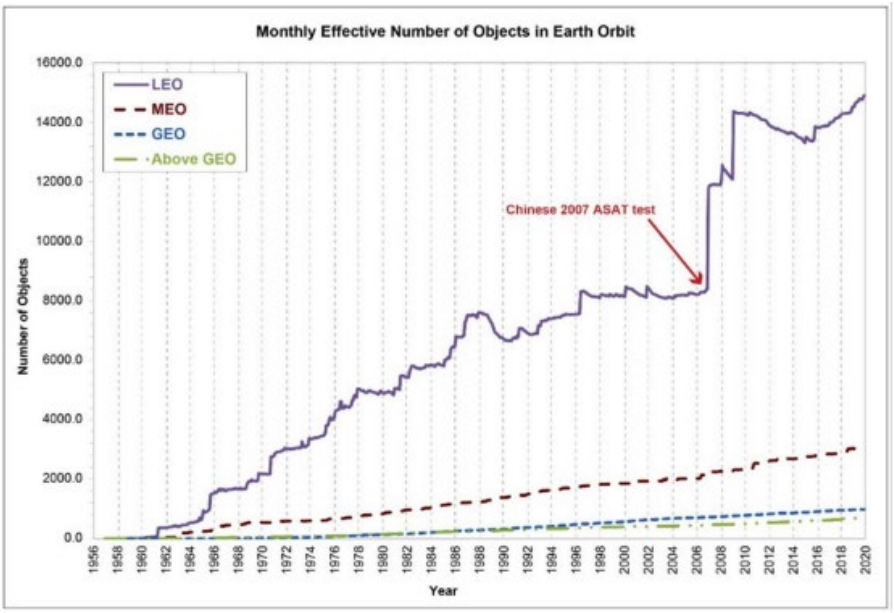

Figure 5: Number of Objects in Earth Orbit[69]

In addition to the DA-ASAT capabilities, China has been developing capabilities which could be utilized in the other main form of ASAT capability, the co-orbital ASAT. A co-orbital ASAT is a weapon that has been placed into an orbit and then later maneuvers into position to impact their target, whether via a direct strike on the target or other means of effecting it.[70] China has conducted multiple demonstrations of technologies which demonstrate a capability for close approach and rendezvous in orbit which would be key in enabling a co-orbital ASAT capability. While they have not conducted any tests to show a destructive capability with these demonstrations, the technological capabilities they have already shown can be rapidly adapted into a functioning co-orbital ASAT. Perhaps most concerning for the United States, is unlike China's DA-ASATs, the technology demonstrations for their co-orbital ASATs have taken place in both LEO and geo-stationary orbit (GEO), allowing this potential capability to be utilized in all of the orbits used by the United States.[71]

In addition to the direct kinetic capabilities China is developing, they have developed several non-kinetic capabilities as well. They have developed significant jamming capabilities that are capable of disrupting both GNSS, like GPS, as well as satellite communication systems (SATCOM) and Synthetic Aperture Radars (SAR) aboard reconnaissance assets.[72] This jamming can degrade the benefits gained by militaries from GNSSs, SATCOM, and SAR assets, though current estimates believe this will only be a degradation, not a full denial of the capabilities.[73]

China is also working on developing directed energy weapons, such as lasers and high-powered microwave emitters, which can be utilized to interfere with or even disable a satellite in orbit from a ground-based facility.[74] Though they haven't publicly announced the test of this capability yet,[75] similarly to their co-orbital ASAT capability, there have been several non-military research projects which could easily be adapted to a counterspace directed energy weapon

capability.[76] Ground-based capabilities, once fully developed, would mostly be capable of effecting satellites in a LEO orbit, not any of the orbits farther out, and current estimates put the ability of a space-based directed energy weapons as further away from potential fielding as a military counter space capability.[77]

In the cyber realm, even less is known about current Chinese capabilities to utilize cyber as counter space capability. However, China maintains a robust general cyber warfare capability,[78] which, though it may not be quite advanced as the United States' capabilities, are continuing to advance at a rapid pace, and pose a threat to them.[79] While these capabilities have not been utilized in the space domain yet, it is a fair assumption that they can be easily modified to be effective there as well.

China currently possesses a capable DA-ASAT capability and numerous jammers, both of which will significantly contest the space domain in the case of a war with China. Additionally, within the next few years, they will be capable of fielding a co-orbital ASAT, a directed energy capability, and deploy cyber operations to add their ability to contest the space domain.

Russian Counter Space Capabilities

As noted earlier in this paper, the last several National Security Strategies have continued to call out Russia as one of the primary threats the United States and its allies.[80] Russia started in a very advantageous position in comparison to the Chinese counter space capabilities, as they inherited the successful Soviet space program at the dissolution of the Soviet Union and continues to make them a serious threat to the contesting of the space domain.[81] While it seems likely that Russia's space capabilities will be surpassed by China in the coming years,[82] and the conflict in Ukraine has hampered Russia's long-term ambitions,[83] they still possess a robust counter space program with tested kinetic and non-kinetic capabilities.[84]

Despite having the potential capability for a DA-ASAT, Russia has only recently field tested this capability.[85] In 2021 Russia test fired a DA-ASAT against one of their own satellites in LEO, Cosmos 1408, hitting and destroying the satellite. Much like other DA-ASAT tests conducted by other countries, this test caused a significant amount of debris to congest the space domain, and even caused NASA to direct the ISS crew to seek shelter in their escape craft. Unlike previous tests, this test was aimed to guide debris into the earth's atmosphere, lessening the risk caused by the debris.[86] Though this test was successful, Russia still has not fielded a fully operational DA-ASAT capability, though that will likely happen in the coming years. Russia has also demonstrated a co-orbital ASAT capability, and unlike China, these have been specifically ASAT capabilities, rather than just the technological capability to field a co-orbital ASAT.[87] USSPACECOM has categorized numerous tests of Russian systems as ASAT tests in orbit, which seems to indicate that this capability is being fielded by the Russian military.[88]

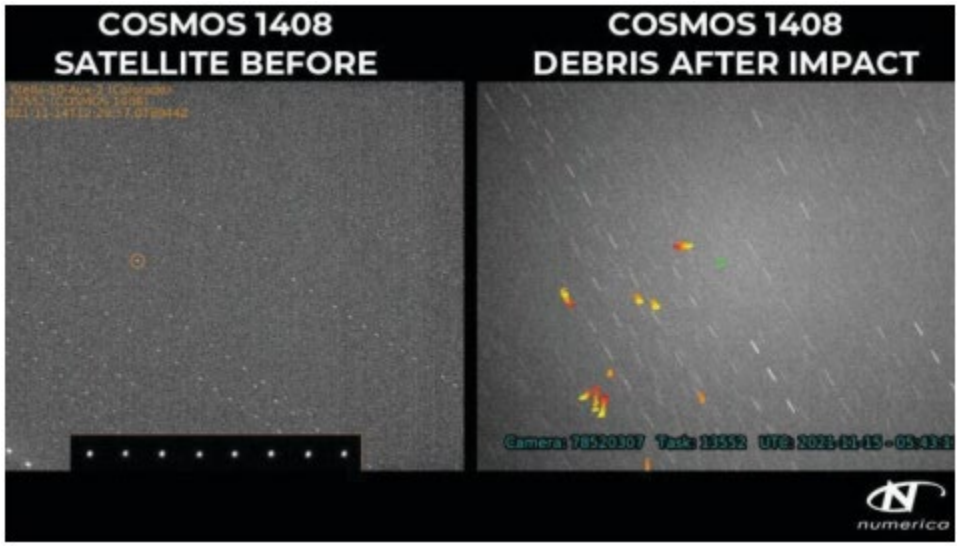

Figure 6: 2021 Russian DA-ASAT Test Results[89]

Similarly to China, Russia has developed a number of jamming capabilities, and like China these are also focused on the GNSS, SATCOM, and SAR capabilities of their adversaries.[90] Russia has placed a high emphasis on their electronic warfare capabilities as a military, which reflects in

both the numbers and effectiveness of their jamming capabilities.[91] These jammers are not only deployed to protect critical Russian facilities, but Russia also maintains a robust system of mobile jammers they can deploy to support their forces.[92] They are also working to develop a space based jamming capability, which would impact a satellite's capability to effect anything on earth, rather than just jamming in a localized area on earth.[93] Despite the robustness of their capability, the impacts of Russian jammers will be similar to Chinese ones, where they will likely degrade space capabilities, but not completely deny them, though Russia's proliferation of this capability will allow them to cause such degradation on a large scale.

One of the unique features of the Russian counter space programs is that many of them are simply regaining capability that the Soviet Union passed on to Russia, but Russia then lost either the ability to continue developing or even maintain the capability. One of these capabilities was a functional laser system which could disrupt the optical systems of reconnaissance satellites.[94] Recent efforts have led to initiatives to both restore this system and develop a new laser system designed to help protect Russian Intercontinental Ballistic Missile (ICBM) sites from being observed by satellite.[95] Unlike China, there is no evidence that Russia is working to develop a space based directed energy weapon capability to complement their ground-based systems, and their current technology will not support such an effort in the near future.[96]

In the cyber realm, like China, Russia has also worked to develop a robust cyber capability to impact United States operations, often using these capabilities to help to infiltrate foreign government systems. Unlike China, the United States views the potential for Russian cyber-attacks on space-based assets as a more pressing concern, even voicing specific concerns about Russian cyber-attacks against commercial and government satellites.[97]

Despite being considered less advanced than China, Russia maintains a counter space capability that in many ways can be considered more advanced than China's capability. While they have not operationally deployed DA-ASATs, they have tested them successfully and can deploy them to support their demonstrated co-orbital ASATs, jammers, directed energy weapons, and cyber capabilities within the next few years. Russia is certainly one of the most dangerous potential actors when it comes to turning the space domain into a contested domain for the United States military.

Iranian Counter Space Capabilities

While the National Security Strategy calls out Russia and China as the most consequential geopolitical challenges, the strategy has also called out Iran as a smaller autocratic power that is acting in an aggressive and destabilizing way.[98] With one of the largest space programs in the Middle East, Iran has also focused on space as a warfighting domain since at least 2009 when it reorganized its Air Force into an Aerospace Force with an added focus on the space domain.[99] Much of this focus has been on developing a launch capability, which could also be utilized for ballistic missile technology, but also on several counter space capabilities.[100]

Iran has not yet developed or tested a DA-ASAT or co-orbital ASAT capability, and it appears that their current technology level is unlikely to be able to produce that capability in the near term. However, they do currently have a robust ballistic missile program which could provide a launch platform for kinetic kill vehicle to grant them a DA-ASAT capability.[101] If they were to make a breakthrough, or receive a technology transfer, such as the ones they've received from Russia on missile technology,[102] that could change quickly.

Iran has developed some jamming capabilities, and coupled with their cyber capabilities constitute their main counter space capabilities.[103] These capabilities have been demonstrated to

be effective in impacting civilian SATCOM signals, which can easily be repurposed towards military SATCOM signals, though their effectiveness against the more robust capabilities of a military SATCOM signal is uncertain. Of more concern for the United States is the potential GNSS jamming, as Iran appears to have interfered with the signal of a United States Unmanned Aerial Vehicle (UAV) enough to cause the UAV to land in Iran for capture.[104] That demonstrates an effective jamming capability, which would require careful planning and support from space forces to overcome effectively.

Iran has not developed any directed energy weapon capability and does not seem to be working towards a future development of this capability.[105]

Finally, Iran maintains a robust cyber capability which can be utilized as a counter space capability by hacking into space systems.[106] The United States Intelligence Community assesses that Iran has been working to penetrate United States and Allied networks, partially for espionage, but also to be positioned for future cyber-attacks.[107] This penetration, if successful, can have Iran positioned to use cyber to impact space capabilities of their adversaries.

While lacking in the kinetic and directed energy counter space capabilities, Iran maintains an effective series of jammers and cyber capabilities that can contest the space domain during any conflict in which they choose to use them.

North Korean Counter Space Capabilities

In much the same way that the National Security Strategy called out Iran as a smaller autocratic power that is acting in an aggressive and destabilizing way, the most common country also called out in that same way is North Korea.[108] In keeping with those similarities, North Korea's counter space capabilities are similar to Iran's, though even less robust than what Iran is capable of fielding.

North Korea has not developed or tested a DA-ASAT or co-orbital ASAT capability, and like Iran, lacks the technology to develop a kinetic kill vehicle for a traditional DA-ASAT or the capability to command and control a co-orbital ASAT.[109] One difference from Iran is that North Korea possesses at least some nuclear warheads, which could be combined with their known ballistic missile capability to become a counter space weapon via the electromagnetic pulse (EMP) the warhead would generate. There is uncertainty on the effectiveness of this given the limited yield of North Korean nuclear warheads combined with the hardening against radiation and Emp effects that most military satellites possess. There are also the potential international repercussions, as this sort of weapon would be indiscriminate in its targeting.[110]

North Korea has demonstrated some limited amount of jamming capability, effecting both SATCOM and GNSS capabilities of civilian devices. There is uncertainty on how effective the jamming capability would be against military capabilities, but further development over the next several years could enhance this capability to the point of effecting military signals.[111]

North Korea has not developed any directed energy weapon capability and does not seem to be working towards a future development of this capability.[112]

North Korea has several cyber capabilities at its disposal and has shown that it will use those capabilities against the United States and its allies in the past.[113] Though many of these capabilities have been used mostly for economic bolstering of North Korea in the past, they can easily turn that capability towards space assets, especially if their operators have gained additional experience and new cyber technologies are added to their inventory.

While lacking in kinetic and directed energy weapon capabilities, North Korea remains a threat to contest their adversaries in space due to their potential for indiscriminate EMP attacks via

nuclear weapons, as well as more focused counter space capabilities such as jamming and cyber-attacks.

FUTURE SCENARIOS

The contesting of the space domain highlighted by each of the driving forces discussed above is concerning on its own, but the United States response to those capabilities being utilized against its space capabilities will be commanded and controlled by a process that was originally set up for an uncontested domain. This is not to say that the processes will instantly fail, however an examination of potential fictional, yet plausible, scenarios may help to identify some weaknesses and ways to address said weaknesses before they deal with a real-life version of these scenarios. Each scenario will outline the impacts of how well USSPACECOM command and control structures support the fulfillment of its objectives. These scenarios will focus on the execution of doctrine as written, rather than any deviations individual units might take during a conflict. Scenario 1 will envision a world where the United States and China enter into armed conflict with one another over the island of Taiwan, focusing on the impacts of Chinese counter space capabilities. Scenario 2 will envision a similar scenario, this time with Russia and the North Atlantic Treaty Organization (NATO) alliance going to war in Europe, focusing on the impacts of Russian counter space capabilities. Scenario 3 will look at a scenario where United States forces are engaged in a conventional conflict with Iranian proxies in the Middle East, and the impacts of Iranian counter space capabilities. Finally, Scenario 4 will envision a world where North and South Korea resume the Korean War, with the United States supporting South Korea, and the impacts of North Korean counter space capabilities on that support.

Scenario 1: The War for Taiwan

In 2029, after years of building tensions, the Chinese Communist Party (CCP) finally launches the long-expected invasion of the island of Taiwan to "reunite" the island with the rest of China. Intelligence indications and warnings gave both Taiwan and the United States warning of the coming attack, allowing both countries to have their forces prepared to meet the invasion.

Shortly before the invasion kicked off however, United States and Taiwanese forces started reporting degradation in their SATCOM communications and numerous errors in their GPS systems. Chinese jamming capabilities seemed kick off an early start to their campaign, disrupting American and Taiwanese coordination. United States Indo-Pacific Command (USINDOPACOM) immediately coordinated a SSR with the CSPOC to bring in more robust SATCOM and GPS capability to counteract the jamming. Fortunately, with the indications and warnings, the CSPOC had been able to draft a CSTO with the projected space support INDOPACOM would require in the opening phases of the invasion, and it was quickly able to task the proper space units to support INDOPACOM's request.

As the invasion and the United States' response to it continued, the USINDOPACOM's COD-Space shop, which handled coordinating support requests between USINDOPACOM and the CSPOC, steadily became task saturated as the scale of the conflict expanded. Additionally, after the initial stages of the conflict conclude, China started to utilize more of its counter space capabilities.

Beyond the jammers that were utilized during the opening stages of the conflict, and continued to be used extensively, China started using its newly developed ground based-laser capability to blind United States satellites in LEO. China knew how much the United States relied on its space-based reconnaissance assets to help plan operations, so they were a priority target for their counter-space capabilities. Coordination between CSPOC and USINDOPACOM was

extensive, but the lengthy process to either develop multiple SSRs or a new CSTO to task units to cover the blinded satellites was slow enough that multiple operations had to occur without the support of space-based reconnaissance.

Additionally, China's new co-orbital ASAT satellite was spending significant time moving about the United States' GEO-based SATCOM satellites. While this capability was not utilized to attack any of the satellites, standing taskings from previous CSTOs directed the SATCOM units to focus on avoiding contact with the Chinese satellite, and without an updated tasking the units followed this order. This caused many disruptions to the jamming resistant SATCOM capabilities USINDOPACOM was relying upon to coordinate its forces.

While unable, or unwilling, to go for direct, irreversible attacks against American spaced based capabilities, the varied counter space capabilities deployed by China were able to blunt much of the joint force's technological edge by contesting the space domain. Due to the slow responsiveness of the command and control structures utilized by USSPACECOM, even the partial impairments utilized by the Chinese lasted longer than it should have, giving more parity between the American and Chinese forces, and causing the conflict to drag on for several years.

Scenario 2: War with Russia

In 2029 tensions between the Russian Federation and NATO reached an all-time high. Russian losses in the Ukraine war in the early '20s seemed to weaken the country, but after the end of the conflict, Russia applied the lessons learned to its military forces and has retaken its position as a top military power by 2029. At the same time, many European countries have become even more dependent on Russian energy sources, leading to increased Russian influence over those nations, and leading Russia to assume that it could use that influence to stave off a NATO response to its potential actions. Therefore, there was a fair amount of surprise when Russia tried another

invasion of Ukraine, which had been admitted to NATO two years earlier, and Russia's influence was not enough to stave off a response from the alliance.

Russia utilized its counter space capability effectively at the start of the war, its jamming, directed energy weapon, and cyber capabilities hampering the initial Ukrainian response. Those capabilities stayed engaged as the other members of the NATO alliance deployed forces to support Ukraine, and a large-scale war kicked off in Eastern Europe.

Caught by surprise, USSPACECOM worked to enact its war plans for supporting the joint force in a conflict with Russia. However, as specific situations were identified, the CSTO processes slowed down the taskings to modify the posture of space units to account for the counter space capabilities being deployed to support the Russian war effort. Once the initial CSTO was delivered, space forces postures modified, and support from their capabilities made it to the joint forces on the ground. Unfortunately, the delay had allowed Russia to make some significant inroads into Ukraine and establish defensive positions.

The war continued to drag on from this point. United States European Command (USEUCOM) continued to press the conflict. When supporting USEUCOM operations, the CSPOC was typically capable of working through its own processes to supply the required support, despite the contested nature of the space domain. However, when emergent requests would make their way to the CSPOC, typically to restore a capability lost due to Russian counter space capabilities, there would be a longer period before the proper SSR or CSTO update would processes to task the proper unit to restore the capability.

This situation took a turn for the worse six months into the fighting, when Russia launched a DA-ASAT at one of the primary American reconnaissance satellites supplying information on the conflict. The DA-ASAT hit the LEO satellite, and the resulting debris field caused massive

destruction across the LEO orbital regime. As USSPACECOM started to respond, the CFSCC realized, based on the delays to operations that relying on the CSTO and SSRs had already caused, that to try and save LEO satellites USSPACECOM would have to do something different. In a radical departure from standard procedure, the CFSCC ordered all space units to maintain their LEO satellites capabilities to the war effort, while working to preserve the satellites from the debris field, with a focus on satellite preservation. This disregarding of the standard tasking process allowed the units the flexibility to preserve their satellites, while still providing some capability to the joint warfighter. While the flexibility was useful, it also demonstrated the limitations of the coordination between space units, as they were not equipped to coordinate with one another, and relied on that coordination being handled by CSPOC.

Shortly after this incident, and with pressure from the rest of the international community due to the massive loss of space capabilities in LEO, a negotiated cease fire was enacted, and the war ended with both sides returning to their 2029 borders.

Scenario 3: War with Iranian Proxies

In 2029, after on again off again attacks against shipping the Red Sea, the United Nations passed a resolution condemning the actions of the Houthi forces based in Yemen and calling for a coalition force to stop the attacks. The United States led the coalition forces, which included several European and Asian nations, including the United Kingdom, France, and Turkey. The coalition planned to utilize limited forces to try and prevent any escalation into a larger conflict. Because of this, the coalition was extremely reliant on support from the space domain to act as a force multiplier.

As coalition forces prepared to enter Yemen, USSPACECOM prepared its units to support the force via an updated CSTO, providing the initially requested support to the coalition forces.

However, as the forces entered Yemen, intense jamming occurred, interfering with their SATCOM and GPS capabilities. While this capability was beyond what the Houthi's should have possessed, no members of the coalition were able to identify the source of the jamming. United States Central Command (USCENTCOM) took lead on coordinating with the CSPOC via its COD-Space cell, and within a day a SSR to offset the jamming capabilities that were demonstrated was published, and capabilities were reestablished.

This trend continued over the next several weeks, with coalition operations slowed due to the amount of time needed to processes a SSR, though these timelines shrank steadily as both the USCENTCOM COD-Space cell and the CSPOC performed similar requests. However, around two months after operations began, the timelines began to extend once again. The COD-Space cell had not been manned for continuous, 24/7 operations, and had finally reached the point where they could no longer manage to maintain those types of operations out of the available manning.

At the same time, both the units managing the GPS constellation and the SATCOM satellites tasked with supporting the coalition forces started to experience intermittent issues with commanding their satellites. Fortunately for the coalition, the commanding issues did not seriously impact their GPS support, but the issues did impact their SATCOM support. USSPACECOM worked to re-task additional SATCOM assets that were not impacted to support the coalition, but this caused a delay of several days on coalition operations, leading to several targets being missed completely by coalition forces, and allowing several other targets to fortify their positions and leading to increased coalition causalities. It was eventually determined that a cyber-attack was responsible for the commanding issues, and within a few days of this discovery, the vulnerability was removed.

Despite the delays the coalition force was eventually successful in capturing the Houthi bases and ending the attacks. The contesting of the space domain slowed the command and control of space forces, which in turn slowed the coalition force, but in the end, the coalition was still able to complete its objective.

Scenario 4: Resumption of the Korean War

In 2029 tensions on the Korean Peninsula have reached a height not seen since the end of the Korean war. North Korean ballistic missile tests have continued to occur nearly monthly, and the allied response has typically consisted of increased joint exercises. Both sides would condemn the other's actions as escalatory, and occasionally there would be some artillery shelling of unoccupied land by North Korea.

Shortly after one of these exercises in July 2029, the North Korean military launched one of their artillery barrages, but this time targeted a South Korean military installation. This attack prompted an immediate response from the South Koreans, and within hours the Korean War cease fire ended as both sides re-engaged.

The United States' forces already stationed in South Korea immediately supported the South Korean forces, and reached out to USSPACECOM to ensure that proper support from the space domain would be available. The CSPOC started working on preparing a new CSTO tasking units to support the operations already planned for the Korean campaign.

However, shortly after the conflict began, powerful jamming started to block both SATCOM and GPS signals for allied forces on the Korean Peninsula. USINDOPACOM immediately put in several SSRs to the CSPOC requesting more jamming resistant capabilities. Processing and distributing these requests took some time however, and forces on the ground were left without the force multiplying effect of SATCOM and GPS for several days. This allowed the

North Koreans to kick off a general ground invasion and gain a significant amount of ground, even making it to the outskirts of Seoul.

Once the proper, jamming resistant capabilities were brought into play, allied forces were able to push the North Koreans back, and with the additional forces deployed by the United States to support the efforts, they were able to deal with other impairments of their space capabilities, as North Korea continued to attempt to jam SATCOM and GPS signals, as well as launching numerous cyber-attacks.

This stalemate continued for several months until the North Koreans launched a nuclear armed ballistic missile into space, targeting the GPS constellation in medium earth orbit (MEO). Unfortunately, the missile did not have the range to make it into a MEO orbit and ended up only making it into LEO orbit before detonating. Very few satellites were damaged by the explosion, but many commercial satellites were severely impacted by the EMP. As these satellites were within the heavily congested LEO orbital regime, several of them ended up colliding with other satellites, causing a cascading effect across the LEO orbital regime.

United States space forces worked to follow their standing taskings, which included preservation of their LEO satellites, but in doing so were unable to continue to supply their capabilities to the war effort. Fortunately, the SATCOM and GPS satellites which were most critical to the war effort were unaffected, allowing allied forces to retain those capabilities, but a significant portion of the space-based reconnaissance capability was lost for weeks.

Shortly after this incident, and with pressure from the rest of the international community, including China, due to the massive loss of space capabilities in LEO, a negotiated cease fire was enacted, and the war ended with both sides returning to their 2029 borders.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Throughout these scenarios, it is clear that the command and control structure of USSPACECOM is insufficient for dealing with the realities of a contested environment. To allow the command and control structure to augment rather than hinder the accomplishment of the core responsibilities of military space forces of preserving freedom of action in space, enabling joint lethality and effectiveness, and providing independent options to achieve desired strategic effects some changes should be made. While likely to be effective enough in conflicts with belligerent powers with less capable militaries such as Iran or North Korea, a conflict with near peer adversaries, such China or Russia, will expose the limitations of the current structure. In order to improve these structures, a few recommendations are proposed.

Recommendations

First, USSPACECOM should move away from the former Air Force command and control tenant of centralized control and decentralized execution and embrace the centralized command—distributed control—decentralized execution tenants of mission command. Mission command is being used across the joint force to better command forces in a complex and uncertain environment that maintain a high tempo environment and where those closest to problem may have the best method to solve the problem.[114] Based on the scenarios above, the space domain would greatly benefit from the enhancements that the mission command doctrine promises for command and control in a contested environment.[115] Mission command is already utilized by virtually every part of the joint force, but is not mentioned at all in the space operations joint doctrine. Moving to a mission command style of command and control would allow the individual units more flexibility to respond to developing situations, while building the trust inherent in mission command, as well as establishing a robust commander's intent, will allow the leadership of USSPACECOM to know

their objectives are being met. Mission command supplies the means for command and control via commander's intent, mission type orders, and decentralized execution,[116] which leads directly into the second recommendation.

Second, USSPACECOM should change from using the CSTO as its primary tasking order for space operations to utilizing a Combined Space Mission Order (CSMO). This updated order would be based in the precepts of a mission type order rather than a tasking. This means that the CSMO would outline the general situation, mission, and execution of the overall mission, as well as providing commanders intent to empower the subordinate space units with the greatest possible freedom of action within the guidelines of that commander's intent.[117] Lower level commanders would then be empowered to react more quickly to situations that arise with their capabilities, and be able to react how higher headquarters would intend them to react. Exercises before a conflict, and mission assessments after those exercises and operations during a conflict will give the combatant commander confidence that their lower-level commanders are executing their missions appropriately.[118] The CSTO could be kept, potentially with a reduced scope, to make an intermediate step between SSRs and the CSMO for USSPACECOM to task space units with extremely specific missions.

Third, USSPACECOM and the USSF need to invest in the Joint All Domain Command and Control (JADC2) concept. One of the potential issues with moving to mission command is the horizontal coordination between space units that will need to occur to support this. Currently, space forces mostly coordinate in a vertical method, passing information up and down the chain of command to allow decision-makers at a centralized location to develop orders responding to situations. To make mission command truly effective, information will also have to pass horizontally between space units that have information critical to enacting the commander's intent.

JADC2 is the joint force's new approach to command and control, with a strategy to sense, make sense, and act. An integral part of the sense strategy includes data sharing options across the joint force,[119] which will be key to enabling mission command. With this new command and control concept, USSPACECOM units will be able to communicate and share information not only with higher headquarters, but one another. This will increase the effectiveness of the mission command style and the CSMO, as units will coordinate to meet commander's intent with the flexibility they need to accomplish their mission. Currently the USSF has not announced that it is working on a JADC2 system for space forces to utilize for command and control, but this needs to change to help enable mission command for space forces.

Fourth, USSPACECOM should give some consideration to developing deployable teams to augment command and control nodes. This recommendation is separate from the previous mission command related recommendations and could be rendered unneeded if they are adopted. Current processes are time intensive, and additional manpower may help to compress those timelines. If a more efficient process cannot be adopted, then bringing in more manning to speed up the inefficient process could prove beneficial. Additionally, in past conflicts it was observed that the manning at geographic combatant commands COD-Space cells have not been sufficient for extended operations,[120] and these teams could be deployed to augment the COD-Space cells. Having these deployable teams trained and ready, USSPACECOM will have a ready force to augment their own command and control nodes, or others the joint force requires to maintain operations.

This paper provides some insight into the capabilities of the current space domain command and control structures. Through scenario-based methodology, the potential shortfalls of this system were discussed, and several methods that could be utilized to mitigate or eliminate

those shortfalls were proposed. It is this author's recommendation that all efforts be utilized to improve and streamline the current space command and control structures to ensure that the United States' priceless advantage from its space assets is not squandered.

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