Reconceptualizing the Space Domain Beyond Historic Perspectives of Warfare

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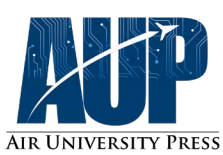

Contents

Schriever Papers

Following the establishment of the U.S. Space Force in 2019, Air University Press launched the Schriever Paper series to provide a forum for discussion of topics focused on space in general and the Space Force in particular. Named for Gen Bernard A. Schriever, the founder of the space and missile force, the series highlights contemporary issues and future challenges in space and the establishment and development of space forces and the domain writ large.

DR. PAUL HOFFMAN
Director, Air University Press

Abstract

Strategies for waging land, air, and sea wars have been ongoing for as long as humans have existed in those domains. Technological advances over the last century have necessitated the development and adoption of war strategies in the space and cyberspace domains. There are significant difficulties in how institutions are adapting technology, especially in artificial intelligence and the corresponding education in relation to the constraints of the space domain. This work seeks to address some of these issues and offer areas of consideration to individuals who are at the forefront of these domains.

Introduction

War is an unavoidable manifestation of political, societal, and cultural disagreement that expresses in rationalized acts of organized violence.[1] Humans wage war, engage in diplomacy to monitor, regulate, and deter wars, and form alliances and partnerships in anticipation of future wars.[2] Military theorists and strategists tend to orient toward new technologies, war tools, and organizational constructs to form hypotheses on how future conflicts might develop, and how one should prepare and wage them. These hypothetical efforts tend to tilt toward description, warfare practice, and speculation on how emergent technological or scientific developments might transform war toward an unrealized advantage of the technologically advanced proponent. There is far less critical reflection of how war changes, why it occurs, and how future wars might depart dramatically from historical precedent.

Space and cyberspace are new domains where war has already been exercised in limited ways. The initial steps into these domains represent a new era in war strategy, one that will profoundly develop in the coming decades with technological and societal expansions. The first rocket to reach space was launched by the Nazi regime during World War II, and later, their captured scientists formed the foundation for the American and Soviet nuclear and space races during the Cold War. The post-WWII American military industrial complex led to the development of the internet, originally a Department of Defense contracted experiment in the late 1960s into the 1970s for a computerized, national data network the military could exploit for security applications. The Persian Gulf War (1990–1991) is considered the first conflict where space played a significant role, while the post 9/11 era conflicts demonstrated extensive use of cyberspace for military activities from clandestine to overt, high-intensity warfare. Yet today, militaries, policy makers and governments alike struggle to understand what future conflicts involving space (and cyberspace) will be like, and how they may require new ideas, new strategies, and the adaptation of different military concepts so that the consequences of possible military action are more developed and appreciated before implementation.[3]

This paper highlights the gaps in current security thinking and military education concerning space warfare, the space domain, and how space defense entities contribute to defense efforts differently than currently conceptualized. It also reconceptualizes space warfare and the space domain as distinct from historical air-land-sea constructs, which require distinct and novel theory, methods, language, and models for future wars. Militaries, as bureaucratic institutions with profound self-interests and ritualized belief systems, tend to

project terrestrial and historical constructs on space warfare; we want to make anything new understood using legacy and institutionally approved ways.[4]

When militaries correlate the space domain with terrestrial ones, they configure flawed strategies and military campaigns. Space warfare is underdeveloped strategically, and many legacy concepts are grounded in terrestrial warfare, forced into what is a different and still unrealized new area of human activity (including war). Just as the rise of steam power transformed how societies understood time and distance, the expansion of human activities into space and the unavoidable security requirements therein require a similar leap from terrestrial to celestial war conceptualizations.[5] War, as a human design, continues to change its form and function as humanity enables our species to think and act in new planes of existence, and the addition of the space and cyberspace domains represent two profound ways that future war is infinitely more complex, even incommensurate with past conflicts.

This is not to suggest that past wars, even ancient ones, were not filled with chaos, uncertainty, and complexity within the contextual frames of those combatants. It is reasonable to posit that while earlier people faced war and dealt with the myriad complexities already in continental, maritime, and later air domains, they did not have nor need to worry about war extending into cyberspace, space, quantum, or artificial intelligence constructs. Complex warfare must be appreciated as both contextual to the time and space where it manifests, and that systemically war is emergent, nonlinear, and transformative within how our species conceptualizes reality and manipulates this perception of it through social, technological, and cunning ways. We clever apes once created war and exercised brutal organized violence with sticks and stones, and now continue that horrific pattern with drones, stealth fighters, satellites, and malware. Space is a new, vast, and potentially game-changing domain for human exploration, development, and conflict. It also requires new ways of conceptualizing and reimagining beyond terrestrial and historical norms.

Humans are fragile when hurtling through the air in a plane, or operating deep underwater in a submarine, yet humans in space require unprecedented examination, particularly with the parallel rise of artificial intelligence and human-machine teaming opportunities. The difference between a single-planetary species and that of a multi-planetary one is profound. Another profound distinction likely will be the one between an organically original, biologically evolved one and what could shift into entirely new and dissimilar species or entities when genetic, cybernetic, and artificial intelligence modifications are applied not in thousands of years, but decades. The Strategic Information Group has additional white papers exploring these other important areas of military concern. These are astounding possibilities for all humanity,

but in space contexts these take on particular prominence in that the space domain will be a central driving force for such risks and opportunities. Threaded throughout all of this is the concern of security, defense, and conflict. Humans evolved within the terrestrial domains, and first developed and later mastered warfare within these planes of existence. Today, space represents a new frontier where humans will need to make technological, societal, cultural, and security related leaps to grasp with the new and dissimilar demands of celestial existence beyond the limits of the home planet.

Space as a plane of new human existence differs from terrestrial frameworks where systemic thinking is paramount, and the previous systematic logic of Newtonian styled, terrestrial warfare appears increasingly fragile.[6] This Newtonian frame, inspired by natural science theories, models, and metaphors, would inspire military modernization to adapt and mimic these into reconceptualizing warfare as a modern profession.[7] Lastly, this paper will offer some caution on the rush to produce space doctrine, given the consequences and likely outcomes of any future war involving space violating contemporary deterrence beliefs and expectations. Eccles provides sufficient warning of this with: "The danger of doctrine is that it may become inflexible; the danger in the study of military manuals and in their study of illustrative examples from history lies in the risk that their content can be considered as a substitute for individual creativity."[8] The rush to generate space doctrine for military affairs may stymie creativity on how the space domain requires entirely dissimilar ways of thinking. Institutionalized motives to extend or justify certain terrestrial beliefs, concepts, and identity may further cloud any doctrinal production enterprise.

The Fallacy of Projecting Terrestrial War Beliefs into Dissimilar Celestial Contexts

For over forty centuries of increasingly sophisticated and destructive acts of organized violence, *Homo sapiens* have monopolized war as a socially constructed and physically exercised unique activity in the traditional terrestrial domains. War on land, at sea, and in the air largely defines the vast and brutal history of human warfare. Wylie provides one of the few attempts to create a general theory of warfare that considers multiple domains and how humans understand war and execute warfare differently whether one is a soldier, sailor, or aviator.[9] In his "general theory of power control" first published in 1967, he provides one useful critique of how soldiers conceptualize a continental war strategy, while aviators and naval forces bring forward their own domain-specific way of understanding a domain-specific war strategy. His theory provides one

logical foundation for considering if the space domain warrants yet another way to conceptualize a space strategy for war, or if perhaps some existing domain strategy might extend upward to the heavens.

According to Wylie, land warfare differs strategically with that of maritime warfare, and this difference extended in the last two centuries into air warfare as technological developments granted humans airborne war capabilities and effects.[10] Broadly, land and sea warfare differ in strategic pursuits, with one a war of sequential actions and the other cumulative. Granted, these are broad abstractions and represent philosophically how military strategic theorists frame war on land and sea at ontological and epistemological levels.[11] Complex warfare implies many conflicts feature hybrid formations of both, yet land warfare in general pursues sequential expansions of valued territory for control or maneuver advantage. War addresses human societies where the continental context is usually primary, with sea and air becoming paramount with respect to land activities. Yet in each of these domains, war differs in form, function, and how they interrelate and influence the exercise of war in domains beyond the one under consideration.

Sequential warfare is composed of "a series of discrete sets, and each step could be clearly seen by the strategist ahead of time, could be clearly appraised in terms of its expected result; and the actual result in turn would lead to the next step."[12] This is how continental warfare, particularly since the Napoleonic period, is conceptualized into campaigns and operational plans along linear, sequential phases and lines of effort toward a desired and clear end state.[13] Gaining the high ground, securing critical access corridors, or defending a population center are demonstrated in sequential war strategies. Modern joint warfare is framed predominantly within the same doctrine, models, theories and language of land armies, and the army as a service maintains a central role to how other services tend to develop and align their own doctrine and strategic planning.[14] Military strategists and practitioners thus tend to project terrestrial, domain-specific war frames upon the emergent and novel space and cyberspace domains out of institutionalized habit, forged in how militaries professionalized over centuries of land-air-sea exclusivity for organized violence.

Cumulative war strategies are nearly as old as ground force maneuvering, where humans realized early on that large bodies of water change how warfare occurs. Naval engagements occur at sea, complete with drift and depth denying any real permanence of occupying a fixed location except in limited cases.[15] The maritime domain is one of cumulative war strategy in that each force seeks sea superiority and later still, dominance over any seafaring opponent. Wylie uses World War II and the Pacific Theater to explain this: "The tonnage war waged by the American submarines in the Pacific was quite unlike the serial,

the sequential, type of strategy. In a tonnage war it is not possible to forecast, with any degree of accuracy, the result of any specific action."[16] Maneuver of ships is a prerequisite to destroy them, and arguably there are examples of naval maneuvers where a fleet abdicates due to inferior positioning with little or no destruction. Naval strategist Julian Corbett argued that earlier naval strategy was too fixated on naval warfare for navy goals independent from continental affairs, and that modern warfare would require a joint, multi-domain and maritime strategy instead. Corbett broke from Mahan and position "denial of access" as paramount to fleet destruction, yet even this requires a *cumulative* approach to position, maneuver, and power projection across the entire sea area of conflict.[17]

Fleets can be outmaneuvered, deterred or denied access to critical waterways, ports, or otherwise rendered unable to secure communication and movement of resources in the sea domain. Corbett departed from Mahan's maxim of fleet concentration at critical moments of pure Clausewitzian (hence continentally inspired) offensive action and instead prioritized occupation of "maritime communications and [closure of] the points of distribution" so that the entire nation is paralyzed and unable to coordinate continental and maritime power.[18] Corbett thus suggested what Sun Tzu wrote some twenty-six centuries before where an *indirect* strategy and a cunning military leader might win without fighting.[19] One can defeat enemies on the sea or in proximity to it at times without direct destructive actions, however, this merely delays the overarching strategy for the maritime domain, which is ultimately a cumulative effort to seize command of the sea from a rival. This is done through destruction or deterrence, which Corbett summarized with:

> In the first place, "Command of the Sea" is not identical in its strategic conditions with the conquest of territory . . . You cannot conquer sea because it is not susceptible of ownership, at least outside territorial waters . . . you cannot exclude neutrals from it as you can from territory you conquer [sequential land strategy]. In the second place, you cannot subsist your armed force upon it as you can upon enemy's territory . . . The only safe method is to inquire what it is we can secure for ourselves, and what it is we can deny the enemy by command of the sea.[20]

Despite this distinction from land forces and sequential strategic orientation, maritime theorists such as Mahan and Corbett still invested extensive analysis of Jominian, Napoleonic land maneuver concepts into sea warfare.[21] Corbett equated land warfare's fixation on offensive destruction of rival armies with naval strategies in that both armies and navies must ultimately control communications pathways in the land and sea domains.[22] Corbett associated the

disruption of maritime commerce with how a nation-state can resist, again illustrating Clausewitzian tenets on breaking the will of a population in Westphalian terms and definitions. Naval strategies overlap with land strategies in the destruction of enemy forces so that domain-wide effects are realized, despite each domain stipulating strategic emphasis on different paths toward accomplishing these goals due to the nature of domain difference. Both strategies may manifest in various domains, but only one takes overarching prominence.

For millennia, naval fleets sought to locate, out-maneuver, engage, and destroy adversaries in the sea domain. While maneuvering and gaining brief positions of advantage remain valid in all physical war domains, sea (and later air) strategy orients toward cumulative deterrence, defeat, and destruction of sufficient enemy maritime or air forces so that one's remaining sea and air forces control access and maneuver in the sea or air space. Mahan cites Lord Nelson on this by saying, "What the country needs is the annihilation of the enemy. Only numbers can annihilate."[23] Destroying an entire fleet could create conditions where only a few vessels are needed to secure vast waterways, whereas large armies must in sequential strategies continue to occupy and control critical land locations and sequentially operate to maintain advantages.

This maritime phenomenon also manifests for air superiority and air dominance. In promoting air power theory, Douhet argued that the "command of the air will be gained when the enemy's planes are reduced to a negligible number incapable of developing any aerial action of real importance in the war as a whole."[24] Douhet bridged this cumulative strategy with naval forces, saying that "a fleet can be said to have conquered the command of the sea even if the enemy still has a few boats; and Independent Air Force can be said to have conquered the command of the air even if the enemy still has a few flying machines."[25] The numbers are framed cumulatively in terms of destruction, availability, and force projection across either domain. Navies and air forces engage rival air and maritime forces so that the rival cumulatively loses any relevant ability to project military power into either domain.[26] Illustrating the cumulative distinction from sequential further, destroyed ships sink to the bottom, while downed planes wreck on the ground, removed entirely from either domain for remaining combatants. Rapoport summarizes this with:

> In contrast, battles on the seas and especially in the air do not result in expansion or contraction off well marked territories controlled by the adversaries. Rather, encounters result in differential losses of military potential (ships, aircraft). It is assumed that the cumulative effect of these losses eventually becomes decisive.[27]

Space, acknowledged as an increasingly prominent war domain over the last eight decades, is often defined inappropriately either by extending aspects of maritime war concepts into space, attempting the same with the air domain, or by extending Napoleonic era land warfare theories into space. Some theorists posit that the security challenges of space are less related to cyberspace or the nuclear age, and are more "like the South China Sea," a conceptualization of geography where colonial powers compete and battle over vast resources.[28] In Wylie's multi-disciplinary, multi-domain effort in military strategic theory first written in the 1950s, he speculates on whether air theories are extendable into aerospace with the explosion of first generation space technology, demonstrating a competing argument to extend another domain's constructs into the emerging space domain.[29] Recent theory on space power by Hendrix and Shevin-Coetzee also make extensive arguments on the extension of classical maritime theory, like those given by Mahan and Corbett, that should pair with emerging space domain security contexts beyond ground or air strategic theories.[30] In some ways, space does share many commonalities with previous maritime, continental, and air power theories and methodologies.

Yet projecting the warfare frames developed for one domain into another one with the expectation that space military forces might clearly understand space warfare just as the navy practices maritime warfare, or how air forces approach the air domain is a dangerous assumption given that no space conflict has occurred yet, nor does any nation have any significant space power outside of cislunar space, if even beyond low earth orbit.[31] Hendrix and Shevin-Coetzee suggest contemporary space power is akin to where the ancient Greeks were with the earliest naval forces venturing into the Mediterranean, in conjunction with early continental forces.[32]

All these attempts to extend terrestrial concepts of warfare into space are problematic in that space as a domain is distinct and may only correlate to certain terrestrial domains in some respects, but not others. Space, as a new and supra-global war domain, expresses strong aspects of cumulative and sequential war strategies that no single terrestrial domain suggests.[33] Shaw, Purgason, and Soileau introduced this term as a proposed remedy to the insufficient existing "global" military terminology that is terrestrially oriented exclusively.[34] Terrestrial military domains demonstrate certain shared, planetary characteristics that the space domain does not. Ships sink and airplanes fall to the ground once defeated, but space systems in orbit remain in orbit, even if destroyed or incapacitated.[35] On land, the destroyed tank remains fixed, with ground forces free to avoid or maneuver around it. An adversary might strike a key mountain pass with persistent chemical weapons, preventing any passage. Yet that ground location is fixed, and forces can seek alternative paths around

it. The chemically contaminated location does not affect anything beyond the fixed locale, whereas a nuclear cloud in space will affect anything with an orbital path compelling it to travel through that cloud. The battleship at the bottom of the sea, like the downed aircraft or ruptured tank have no such overlap. Terrestrial domains are defined by physics and natural science derived laws of motion, yet space should be understood as a celestial domain.

In this respect, even cumulative space strategies may seek to disable or destroy rival space systems in shared orbits but doing so does not necessarily eliminate them from those same orbital paths except in unique circumstances.[36] Even an irreversible, non-debris causing act such as laser dazzling spacecraft sensors, hacking, detonating an EMP orbital blast (with subsequent orbital radioactive cloud) may render many non-hardened and vulnerable space systems inoperable. Such action removes control (even if temporarily) from the system owners while placing those objects at the mercy of gravitational fields and random chance that they might strike something else, including other debris, friendly or adversarial spacecraft. Destroying an enemy spacecraft in the same orbital path as the attacker puts that system in future peril, as any debris created in the strike may come back to haunt the attacker or otherwise create future mayhem in the vacuum of space. The space domain is unique due to celestial physics that cannot be interpreted within familiar terrestrial warfare perspectives alone. Cumulative war strategies in the space domain take on unique and complex conditions unlike terrestrial ones. The land forces and sequential strategies on *terra firma* also do not neatly extend into space and require deeper reflection.

Space features unusual properties due to the laws of physics and how celestial bodies interact in highly complex orbits and other gravitational engagements. Indeed, space as a vacuum technically is the absence of anything, at least above quantum and microscopic levels for military considerations. Sequential strategies involve land forces maneuvering to gain significant positions of advantage, and even in space there are clear "high ground" locations despite the lack of anything substantive there to sense; the tangible hilltops and critical bridges of continental maneuver warfare are reconceptualized with invisible yet profound positions of celestial advantage, including orbits, overwatch of key areas for optimal launch sites along Earth's equator, and other locations in space that are unlike anything in terrestrial domains.

Spacecraft can maneuver or otherwise occupy regions that in space influence or affect larger regions by their unique celestial properties. Space forces can seize and attempt to control contested orbital paths, deny adversaries from entering into orbit or vastly increase launching costs by occupying critical locations in orbit around planets. Space features Lagrange points which are

points of equilibrium for smaller objects between two massive orbiting bodies, such as the Earth and the Moon.[37]

Moving a space system into one of these points means that it will remain there permanently, thus occupation of such a point becomes a military strategic consideration within how sequential war strategies play out in land warfare. The same occurs on other planets, moons, asteroids, and objects of strategic importance, in that placing a weaponized system in a critical extraterrestrial location suggests the ability to prevent adversaries from doing the same. For safety concerns and by extension overlapping military objectives, the positioning of space systems in a key location first has second-order effects that likely deny an adversary from placing their own spacecraft in that same general area. This suggests a reinterpretation of earlier continental maneuver strategies to get somewhere "first with the most men." Continental sequential warfighting strategy thus blurs with cumulative strategies of sea and air domains in hybrid and potentially novel reconceptualization.

Thus, the space domain combines previously understood war strategies of air, land, and sea in unique combinations unprecedented in earlier warfare. There is no equivalent on land, air, or sea where everything in a particular orbital path must perpetually pass through the same area of space (unless a controller spends fuel to adjust it) so that a space sequential strategy applies. In the same context, an adversary that destroys space objects in that same orbit will pursue a cumulative war strategy of attrition, eliminating rival space systems but also likely creating a perpetual debris field that will continue to obey the laws of physics and celestial mechanics. Space frequently combines both sequential and cumulative war strategies in ways unlike the traditional terrestrial domains demonstrate historically. Space debris may, in what complexity theorists call a "positive feedback loop," increase in size so that nothing can safely orbit in those areas at all.[38] The "Kessler Syndrome" might occur in a limited yet high-intensity space conflict, and most certainly in an expanded nuclear one.[39] Coined by the NASA scientist with the same name, a Kessler syndrome or effect is a scenario where the rate at which debris collide and produce greater debris fields exceeds the rate of debris elimination through atmospheric drag, meaning that low earth orbit could become unusable in a highly polluted, clouded orbit of debris impossible to avoid or reduce.

This complicates whether space superiority correlates to similar definitions of air and sea superiority. Douhet, a highly influential and pioneering aviation theorist, said of air superiority: "To have command of the air means to be in a position to prevent the enemy from flying while retaining the ability to fly oneself."[40] He adds that to have command of the air is to have victory, and to conquer the air:

> It is necessary to deprive the enemy of all means of flying, by striking at him in the air, at his bases of operation, or at his production centers- in short, wherever those means are to be found. This kind of destruction can only be accomplished only in the air or in the interior of the enemy's country. It can therefore be accomplished only by aerial means, to the exclusion of army and navy weapons. Therefore, the command of the air cannot be conquered except by an adequate aerial force.[41]

Douhet offers not a sequential strategy where air forces act like armies, but a cumulative one like naval strategies where the domain itself must be conquered by that service, the enemy air (or sea) forces destroyed or otherwise denied access into the domain, and that strategically the other services in other domains will become less encumbered in their own specific war strategies through air dominance over a military rival. Ground warfare and land dominance differs in that as Der Derian frames with "Baconian-Cartesian-Newtonian-mechanistic" modeling, war within the land domain occurs sequentially through organized violence oriented on gaining advantage over adversaries.[42] Continental war, defined in the Napoleonic Era of nation states and nationalized mobilization, sought a mechanistic, orderly, and universal war theorization that attempted to formulate warfare through natural science inspiration.[43]

One's armies maneuvered offensively to strike conclusively at decisive points against the enemy army to destroy it, leaving the nation or targeted population unable to resist. Jomini would advocate Newtonian styled, natural science inspired 'principles of warfare' logic where "all strategy is controlled by invariable scientific principles; and that these principles prescribe *offensive action to mass forces* against weaker enemy forces at some *decisive point* if strategy is to lead to victory."[44] Clausewitz would disagree with the Jominian mechanization of warfare, but address the supremacy of military purpose not with annihilation alone, but the sequential maneuvering and occupation of key objectives so that one gains advantage to ultimately defeat the rival state. This is illustrated with the following:

> If a battalion is ordered to drive the enemy from a hill, a bridge, etc., the true purpose is normally to occupy that point. Destruction of the enemy's force is only a means to an end, a secondary matter. If a mere demonstration is enough to cause the enemy to abandon his position, the objective has been achieved; but as a rule the hill or bridge is captured only so that even more damage can be inflicted on the enemy. If this is the case on the battlefield, it will be even more so in the theater of operations, where it is not merely two armies that are facing each other, but two states, two peoples, two nations. . . . the gradation of objects at various

levels of command will further separate the first means from the ultimate objective.[45]

Thus, Clausewitz orients the strategic purpose of land armies at two levels, with tactical maneuvering and destruction of enemy forces nested in a *sequential* approach to gaining and maintaining an ever-increasing advantage to further destroy the entire national will to resist in a continental framework (land domain). Offensive actions by one army concentrated against the other is done through sequential strategic arrangements on terrain, with strings of tactical victories eventually realized in a final triumph over the entire nation-state.

Those individuals inspired by Jominian and Clausewitzian lessons of the Napoleonic Wars such as Helmuth von Moltke the Elder and Alfred von Schlieffen in turn influenced how land warfare strategy occured in the early twentieth century. Both "taught and practiced a mode of offensive warfare that adapted to the industrial age Napoleon's precept to seek prompt decision by battle [sequential maneuver of land forces] and in battle seek to destroy the enemy."[46] Modern militaries wrestle with what land domain dominance is, but joint and service doctrines almost exclusively subscribe to a combination of Jominian and Clausewitzian constructs.[47] Space superiority or space dominance would relate to warfare in the space domain, and if space exercises novel combinations of dissimilar terrestrial domains and also new, unrealized and space-specific ones not found in the history of air-land-sea warfare, perhaps the notions of "superiority" and "dominance" warrant terrestrial and celestial clarification. If space superiority is a viable concept, it may remain contextually dependent upon superiority in time and space over threats and rivals. Such superiority may be expressed in both sequential and cumulative warfare strategies. Again, the celestial expansion of these previously honed terrestrial warfighting concepts invites the possibility that war in the space domain requires unimagined, novel hybrids and developments beyond all historical precedent.

Space Domain Warfare and Civilian Defense, Resistance, Capitulation

Historically, invading militaries would, once destroying opposing armies and navies, be in possession of critical infrastructure, territory, and populations that would in Clausewitzian terms accept the Westphalian rules of war. Defeated nations lose the will to resist, and their capitulation is exercised in new obedience or toleration of military occupation along with new rules and treaties; at least this is the foundation to modern war philosophy through the analysis of Napoleon as articulated by both Jomini and Clausewitz (despite their

antagonistic theories in seeking explanation of what modern war is and is not).[48] Resistance can occur, and often an invading force might rapidly crush the organized military forces but suffer long insurgency campaigns that sap their own ability to occupy, compel, and enforce.

Terrestrial domains associated with such capitulation or resistance is primarily land and sea based, with examples of piracy, sabotage, and violent or nonviolent disobedience focused on occupation forces, or the very infrastructure or territory prioritized and seized. Piracy as a component of terrestrial warfare suggests that illegal and destructive behaviors tend to thrive at the edges of where state power is unable to dominate in terrestrial domains, whether in literal examples of sea pirates or in how radio pirate stations offshore can influence societal change.[49] Such piracy unavoidably will extend into the undermanaged, or under-governed spaces of outer space, justifying future security demands on an unprecedented scale for humanity.

Space as a domain, like cyberspace, differs from terrestrial, physical domains in several ways and new thinking is warranted for civilian defense, resistance, and capitulation.[50] The space domain features an expanding participation by commercial and civilian entities, including global or multinational corporations that further complicate clear alignment with one state or another in conflict. Unlike commercial enterprises that function within a terrestrial, physical domain (such as a microchip factory or automobile plant), space industry is spread across a multitude of locations that are terrestrial and celestial. Military occupation of one nation, terrestrially speaking, may or may not create conditions where entire space industries must capitulate to the aggressor force. This likely will increase in complication if space industry moves more production off planet, meaning that terrestrial objectives may need to span multiple planets, moons, and other celestial locations to achieve similar effects. Further, space domain constellations of interdependent yet redundant systems could make military capitulation in traditional, terrestrial domain definitions obsolete.[51] The occupation or destruction of one terrestrial node might simply shift control and operation to an unaffected node, or the space enterprise being targeted may be decentralized so that no single offensive military campaign accomplishes more than local or regional degradation., particularly if the strategy fails to address how the space domain changes terrestrial warfare.

Civilian defense traditionally is based on an epistemological position in war that a population "can be induced to refuse to obey," even if the traditional military forces are destroyed or defeated according to modern warfare practices and beliefs.[52] Civil defense attempts to resist military aggression through nonmilitary and nonviolent means. Danish nonviolent resistance of German military occupiers from 1940–1945 is one such example, while Gandhi's non-

violent movement to end British rule in India is another. Unlike terrestrial domain contexts where humans engaged in nonviolent civil defense must take specific actions that collectively undermine enemy military will to fight or reject the stipulations of capitulation, the space domain exists in a supra-global form and function. Few humans are in space, and spacecraft and systems active in space are interconnected with the primary domains where humans do directly interact physically and conceptually. Civilian defense could, due to the detached and decentralized nature of many commercial and civilian space enterprises factor into more significant forms of nonviolent resistance. Further, the independence of private companies in most western democracies suggest individual commercial resistance could make the space domain a contested, yet also possibly a nonviolent area of future conflict.[53]

Companies and civilian enterprises possessing spacecraft or able to act in the space domain may choose to capitulate in a conflict to the aggressor, or they may decide to resist and engage in nonviolent civilian defense. The nonviolent element refers to an assumption that commercial spacecraft are not weaponized, nor in some dual-use configuration where a nation-state can take control or act in a violent manner in space against an adversary. Excluding totalitarian regimes or dictatorships where industry and commerce is under governmental control, nations that have robust space commercial and civilian entities may be unable to control or influence such actors to engage in civilian defense. These decisions may be entirely at the hand of corporate leadership, boards, investors, or populations of key stakeholders.

Warfare activities occurring within the terrestrial domains might create conditions where space actors move to resist or capitulate. Civilian defense may, due to the global and persistent reach of space systems, become a dominant factor in nonviolent resistance and possibly an emergent mode for destroying an adversary's military will to fight. Satellite-based information, propaganda, disruption, and nonlethal targeting are some of the many space domain abilities that could become part of any orchestrated civilian defense. Space industry, particularly if dispersed and arranged internationally or in a manner that otherwise prevents some centralized, hierarchical control over it, may be difficult or impossible for a terrestrial military occupation force to subdue. Unlike previous occupations where possession of territory correlates to power over industry within that territory, space industry may not have such clear, linear dimensions. Civilian defense using space industry may be too remote or otherwise difficult to assume control of, or the control mechanisms of those spacecraft, might be diverted away from the reach of terrestrial military forces.[54]

Civilian defense in the space domain thus differs from how some theorists suggest spacefaring nations may return to the earlier corporations such as the British East India Company or the United East India Company in the Netherlands that used their own private armies to fund trade, explore, establish forts, and negotiate with foreign rulers across Asia.[55] These private companies of the Imperial Age were sponsored by state governments, and represented a fusion of interests across explorers, merchants, and state governments facing a vast, resource rich sea domain where they had technological advantage over indigenous societies. The India companies had offensive military abilities coupled with national authority to wage war, enforce laws, and otherwise act on the behalf of the national benefactor that gained from all corporate enterprise. Civil defense exists below this threshold of overt, mercenary-like activity where a company and a nation are symbiotically linked in foreign policy. It is valid to posit the overlap of how space is similar to these earlier conditions in that enormous energy and resource opportunities await the same combination of space explorers, state governments, and economic enterprises.[56] Existing state space power is still in an infancy, where the exploration, colonization, and commercial exploitation of space should vastly outpace any state ability to provide sufficient yet independent military security or support. This suggests a renewal of commercial enterprise into space where private industry weaponizes and secures their interests against competitors and rivals, particularly when trillions of dollars of space riches are at stake.

The parallels may begin and end at how private space industry may outstrip national protection in space, and potentially self-secure their own activities out of concern for other competitors interfering with their pursuits. Civilian defense in the space domain will not feature any indigenous peoples to enslave, and the majority of first wave exploration and exploitation likely will be heavily composed of sophisticated machines, often alone and reliant upon distant human operators and essential programming codes. The coding used will influence how and if space expansion and exploitation occurs competitively or collaboratively. For human explorers largely alone in the dangerous deep space conditions where they may face difficult circumstances, a unified civilian defense that prioritizes safeguarding of all human life in space could trump or even marginalize competing demands to secure and safeguard space systems offensively.

While Chinese, Indian, Russian, and American governments may seek to impose clear strategies and potentially conduct military activities in space with their own controlled spacecraft, this could align with some commercial and public interests, or it could stimulate broad rejection of such actions. This is unlikely with single industries or scientific groups taking individual pledges on space norms and behaviors, but a comprehensive, cohesive, and international

alliance of commercial space enterprise that is independent of any single state dominance could shift space enterprise to a peaceful expansion of exploration, scientific discovery, collective colonization, and shared economic development. Again, this is hypothetical and breaks from nearly all historical norms, but the space domain may represent the first truly game-changing and novel domain that could marginalize warfare due to human rejection of terrestrial and historical patterns.[57] How might a nation's space force appreciate this possible shift, and how could they in turn adapt new roles and missions in such a future context?

Terrestrial forces exist today to offensively strike against enemy forces or to defend against offensive acts of organized violence. Civilian defense historically has been part of many wars, and collective populations engaged in such resistance cannot be defeated without significant or unrealistic efforts by an occupying or offensive force. The theory of "morale bombing" used by British and German air forces in World War II assumed "the other side's people will give up first, because our people have stronger wills" is an example of how civilian defense functions regionally, even without enemy forces in direct occupation.[58] With humanity now entering an age that likely includes the space domain in future conflicts, civilian defense across space may become a new manifestation where humans on Earth can generate powerful, nonviolent effects on various actors including aggressor forces and their homeland populations. Commercial independence and the interdependence of many actors in the space domain may deter state-based acts of space aggression, leaving the domain as one that exercises persistent, supra-global acts of civilian defense for one party or another. Even if states engage in space domain violence, any unaffected or remaining commercial and civilian spacecraft may decide to capitulate or resist through nonviolent yet powerful abilities of space-based systems.

For the last few centuries, humanity has been largely in the grips of philosophical and political disagreement on what is best for societal existence and prosperity. There is also a deep ideological division over how humanity should progress foward for future development and maximization. Much of this exists in some conflict between liberalism, capitalist democracies, and that of some version of Marxist inspired socialist or communist regime in opposition.[59] Terrestrial wars have been waged, millions of lives destroyed, and countless opportunities dashed. Without offering author bias in favor of one or the other, the space domain could present new circumstances that advance or change the dynamic. The dangers and risks of space coupled with the paramount survival of humans could create conditions where the incommensurate epistemological stances of both societal forces may be softened enough that outer space rescue, care, and safe haven could become a new, overarching paradigm even above national competition. The competition terrestrially for living space, resources,

energy, and power have until now presented no other alternative than perpetual cycles of politics and violence. Yet the space domain presents near unlimited resources, living space, energy, and a unique condition where cooperation should lead to the entire collective prospering or expiring. This is perhaps the ultimate optimistic outlook for the space domain.

Or the allure of near infinite resources, space, and power could lead to what defines the worst in our species. A space race could quickly lead to massive escalation in war, with a combination of continental sequential strategies to get there first with the most, a Clausewitzian offensive mindset bent on total and complete destruction of an enemy, and a space manifestation of game theory run amuck, with each side seeking ever more devastating weaponry and technology in contexts where wars span not continents, but planets and moons. Worst still, one side may hold to particular ethical, moral, or legal standards that are nonexistent or dissimilar in another society, leading to horrific decisions in artificial intelligence, autonomous weaponry in space, and more.[60] These concerns are also unique to the space domain in that while devastating warfare on Earth has yet to become species eliminating, celestial conflict may not only close off the future of humanity on the home planet, but potentially extinguish any chance of colonization and survival beyond our home of origin. This leads to the fragility of humanity, coupled with our cunning abilities to design devastating technology faster than we can develop sufficient ethical, moral, and legal frameworks to safeguard the implementation of such innovations.

Homo Sapiens are Fragile: The Costly Cans of Human Meat Off-World

As mentioned, humans as a species are designed to thrive on Earth, not in space. Humanity remains bound to the home planet for now, and while it is entirely feasible for human colonists and explorers to venture to other planets and even establish permanent settlements, such activities will be costly and challenging in significant technological, biological, emotional, and societal ways.[61] One interesting ontological quality of spacefaring nations is a pronounced centering of the human in space exploration and exploitation, despite the vast majority being done thus far by non-human systems. This leads to several space domain questions on the near and long-term future for both the species and potential violent conflict between various nations, groups, and space actors. Non-human systems already proliferate across the terrestrial domains, yet human decision-makers are still the dominant, central actors in conflicts that occur on land, sea, and air. This also includes cyberspace, and currently the

space domain. While there are humans in orbit on the space station, their work remains scientific and non-offensive in any conflict application. Military actions in space in conflicts such as Ukraine or in deterrence activities between competing nations are done entirely by automated or ground operator-controlled systems aboard spacecraft.

Space was weaponized in the first action that created the Space Age, when a German A-4 rocket reached the edge of space in 1942. The rocket program led to the V-2 weaponized rockets that struck Paris during the Second World War. Today, despite various treaties and agreements restricting the weaponization of space, such a stance is fragile and potentially obsolete—or impossible to enforce. Arms races are often defined through rational actor theory and demonstrate a strong pattern that one rival will invest into new technology out of rational concern that a competitor may also gain some advantage if no action is taken.[62] The nuclear arms race that defined the Cold War continues today, now in a multi-polar context with a range of national actors and possibly proxy or non-state actors as well where proliferation of weapons of mass destruction takes on an ever-expanding and increasingly unstable context. Humans now host an impressively deadly variety of weapons that continue to become easier to produce, miniaturize, and field. The parallel rise in artificial intelligence begs the question of how long it will be until some weapons become controlled exclusively by an autonomous system. Autonomous systems and increased security concerns overlap in the space domain, where such future ethical, moral, and legal dilemmas await.

The space domain favors non-human spacecraft for a host of obvious reasons, and as artificial intelligence continues to progress, the proliferation of autonomous weapon systems in space is potentially unavoidable. Humans are too expensive to position in space (at least for the next several decades) to control the particularly destructive systems such as a nuclear weaponized spacecraft, meaning that should such a technological design be achieved, that system will operate under some sort of AI control.[63] Whether the final decision rests with humans on the ground or internal to the AI system depends on the ethical, moral, and legal positions of the system designers.

War continues to be a human affair where destructive force is violently applied toward an opponent through speed, precision, and understanding. In modern military war theory, the Clausewitzian school dominates by declaring victory is earned by the adversary able to inflict sufficient damage quickly and offensively so that the offensive abilities of the enemy are defeated, thus breaking the will of the people (forcing policy makers to cease warfare).[64] Future wars will involve sophisticated arrangements of humans and machines, operating across all the military domains. How each human-machine team

approaches their relationship and decision making will depend in part on how violence is exercised within that particular domain, and how that domain interacts with other domains. This again is where space is unique and dissimilar from terrestrial domains for human consideration in warfare. Human-machine teams involving space will position the humans outside of space itself (except perhaps in temporary and highly limited contexts), with all spacecraft and systems unmanned, with some semi-autonomous and others autonomous.[65] Across all domains, humans will face the ever-increasing demand to shift decision making to AI systems able to sense, process, and act faster, yet the space domain will present particular and different challenges.

Discussions on human off-world colonization date back to the original space race to put the first human on the moon. Indeed, today's top commercial space pioneers such as Elon Musk and Jeff Bezos envision millions of human colonists in the future living off-world, and potentially all industrial activity shifting to space entirely.[66] The long-term possibilities for technological development to allow such an explosion in growth is exciting, yet in the short term, humans attempting to live outside the Earth's atmosphere struggle and require enormous support just to remain alive. Humans are well accustomed to this planet's gravity and numerous other protections that Earth provides, and most of these would need to be simulated or otherwise overcome.

A century from now, there could very well be a thriving colony of 50,000 humans on Mars, but for the next several decades at least, any humans that make the trip to Mars will be temporary visitors, not colonists. The bulk of their daily affairs will center on survival, akin to the earliest colonists attempting to survive in the New World. Even a moon base, despite close celestial proximity to Earth, is a tremendous undertaking that will take decades to develop so that humans are anything but expensive, fragile visitors. In the harsh conditions of space and the inner solar system, machines will continue to have an edge over humans until such time that technology and innovation provide the human species necessary protection and comfort akin to Earth. For now, most humans will remain on their home planet, and direct space machines or small groups of fragile human explorers to various scientific, military, and commercial destinations. Over time, machine explorations will increase in distance, and in nearly all conditions, the decision makers on Earth will need to consider enormous distances between them and the spacecraft and destinations in space.

The distance between controller and spacecraft is greater than in any other domain configuration, and space systems are becoming increasingly more distant. A satellite in low earth orbit may be controlled directly by a human operator on the ground. These systems might also be semiautonomous or entirely autono-

mous. Systems in geosynchronous orbit or further may take too long to allow the human to be "in the loop" or even "on the loop" as found in terrestrial human-machine teams. Instead, the human may be delegated to "behind the loop" or even "off the loop" where the autonomous AI space system works and acts through sophisticated programing independent of human direct control.[67]

Humans "behind the loop" would remain reactive, understanding AI system behaviors well after the actions are made, while "under the loop" suggests that general AI intelligence and machine learning could produce AI capabilities and behaviors that cannot be readily understood or interpreted by human creators.[68] Advanced autonomous AI systems may generate entirely novel strategies and designs beyond the original intent or purview of human creators, particularly for constellations of spacecraft and strategic designs involving myriad parameters and conditions in a complex, multi-domain conflict. Deep learning and AI systems today are doing this with games such as chess, and it is likely that space defense AI in the future will also figure out unprecedented, unrealized ways to form strategies and operations unlike anything in the human historical record.[69]

The terrestrial domains should undergo hybridization of human-machine team configurations in future wars, given that human actors will remain primary and central in domains and locales such as cities, coastlines, waterways, and other key terrain (including cyberspace where virtual content replaces notions of geography). Perhaps the deadliest of war zones will only feature autonomous AI systems, yet in land, sea, and air domains it is likely that every human operator participating in future warfare will have increasingly robust AI partnering. Such dynamics may become interdependent, in that human combat operators might rely upon a swarm of sensors and systems with cunning AI able to enhance human abilities well beyond traditional battlefield limits.

While human operators of spacecraft will gain similar AI enhancements, their proximity to the distant space systems will unavoidably create circumstances where autonomy is faster and more effective than the slow, clunky, error-prone control of a terrestrial decision-maker. This, of course, opens tremendous debate on the ethics, morality, and legal considerations for autonomous weapon systems, such as whether the operator, decision-maker in the team, or perhaps the original programmer of the code is responsible for any allegation of war crimes by an autonomous AI system.[70] Space as a supra-global domain hostile to humans will complicate this further. Assuming such a space arms race, the question is not if some actor or nation will launch a nuclear armed system into space, but when. The severity of space-based weapon systems and presumed mass destruction abilities further illuminate the disrup-

tive qualities of any space arms race coupled with efforts to cede greater decision-making to autonomous AI entities.

Humans are organic, but can be modified, mutated, upgraded, and potentially transformed beyond original species limitations. There are tremendous ethical, moral, and legal concerns on all these considerations, but those will come with clear security challenges in that some adversaries and competitors will pursue new opportunities that may conflict with current western democratic laws and behaviors. The space domain will represent an increasingly powerful force in how humans, human-machine teams, and autonomous systems are developed for space applications. Humans might be integrated with cybernetic upgrades that enable them to perform and survive in space and off-world conditions beyond what natural humans are capable of. Future humans could be modified genetically so that once born off planet, they are more conditioned to thrive in different celestial or other planetary environments.[71] The organic and cybernetic modifications of humans to function differently in the space domain and off-world are just one part of an emergent technological celestial pathway.

Artificial intelligence represents an important intersection of technology, cyberspace, and the space domain. Space is already proliferated with narrow AI systems and rather simplistic computerized spacecraft doing specific tasks in the harsh conditions of outer space and off-world. General AI represents the next major phase of development, where AI systems will match or vastly exceed human intelligence in every possible way.[72] This might occur in decades or take centuries. There are myriad ethical, moral, and legal concerns with this potentiality, but the clear domain for long-term application for general AI systems is in space. General intelligence AI spacecraft will be capable of simulating, or in some cases, vastly exceeding the more costly and dangerous requirement to put humans into celestial and off-world locations. AI researchers even apply the notion of a "Singleton" entity with true general AI that might become superhuman in intellectual capacity.[73] Should an AI system with general intelligence double or triple the abilities of the smartest human mind, there may be no limit to how far it might progress. An AI entity with an intellect 1,000 times superior to the smartest human may be able to orchestrate space security systems and spacecraft beyond what any collection of humans could, and such a Singleton granted control of some, or all military space security systems would be able to secure societies that are interplanetary, or with economies and resource networks that span the solar system and beyond.

Transhumanism is yet one more area for brief consideration and how the space domain and celestial security affairs will change remarkably. A singularity introduces the concept of transhumanism where at a biological, physical, political, sociological and ultimately a philosophical level, humanity might

evolve beyond the slow, clunky genetic and environmental soup of existence as organic, carbon-based life forms. Transhumanism need not be directly associated with the rise of superior AI, as the two might be better understood in a Venn diagram influencing one another.[74] Transhumanism envisions "our transcending biology or manipulating matter as a necessary part of the evolutionary process."[75] The arrival of a technological singularity coincides with a rapid departure of the transhuman entity away from the original biological evolutionary track.

Transhumanism is another pathway where the intersection of advanced technology and space present radical shifts in what the human species currently understands reality to be, and what a future celestial, interplanetary and distinct species could transform to. This is currently better understood in science fiction and suggests little importance to current security concerns, but the long-term gaze of where the space domain will become perhaps the central domain for any security concerns may include such fantastic ideas. Future transhuman entities may seek to explore space, colonize, exploit resources, and perhaps engage in some recognized or unimagined manner of conflict that still constitutes war. This would occur in space as a domain, and potentially transhuman entities or an AI Singleton would assume protective responsibilities for humanity as a multi-planetary species. These ideas seem fantastic today, but often the assumptions that drive pragmatic expectations of future stability are unimaginative and short-sighted. In 1903, the New York Times predicted airplanes would take another 10 million years to develop.[76] Nine weeks later, the Wright Brothers achieved manned flight. Sixty-six years later, the first human stepped onto the moon. Change happens quickly and often in unanticipated ways that shatter conventional norms.

Systemic Shock: Space and Inter-Domain Novel Combinations

The terms system, systemic, and other variations are frequently found in contemporary national defense strategies, policy papers, and speeches by military leadership concerning the complex security environment our society finds itself. The space domain in particular (but also in parallel with the cyber domain) lends to a new desire for joint, integrated, or whole-of-government and international collaboration in security contexts.

Yet frequently, the ideas within systems thinking and complexity theory concerning systems are not accurately presented or misinterpreted into institutional double-speak. We tend to say systemic but actually continue to extend earlier, *systematic* modes of conceptualization for war, including where sys-

tematic logic in a terrestrial domain is extended intentionally into space so that these linear, reduceable, and quantifiable processes remain within the theories, models, and methods for space strategists. In other words, theorists that posit "domain X has space-like characteristics, therefore the space domain can be understood using theories, models, and methods derived from domain X" suggest systematic logic in their formulations. Space as a domain exercises *systemic* phenomena in war theorization differently than do the traditional continental, maritime, and air domains, meaning that no single domain nor perhaps combinations of terrestrial domain warfare theories are anything but superficially correlative in how complex warfare may emerge in space. This requires a quick explanation of systems thinking and complex, multi-domain warfare.

A system is something conceptually bounded so that when humans seek to understand what a particular system is and is not, there must be some unified whole that differentiates between itself and the rest of reality that is not part of that system.[77] A system is composed of many things that themselves do not collectively cause the system to exist (or not). For example, humans are living organisms composed of millions of cells, yet these cells die and are replaced with new ones constantly. A nation is composed of millions of people, but they too live, die, and create offspring or allow outsiders to become members. Soldiers could lose all their limbs in a horrific explosion, but remain a person, and an infantry platoon could suffer 100% casualties in combat but be reconstituted with replacements and continue to be that same unit. This extends to everything including non-living things, such as rock formations, the moons of Jupiter, or tectonic plates. Jomini, in pursuing universal, deductive principles of war, applies systematic logic where every battle in every possible domain can be frozen, isolated, reduced into smaller parts, and analyzed so that foundational war principles can be determined. One reassembles the battle into the whole and applies the principles formulaically to determine who wins and why. Systemic thinking rejects such thinking for war.

The "grandfather's ax" paradox illustrates how systemic differs from systematic logic. In this story, a man states that he has the ax that was passed down to him by his grandfather. However, last year the handle broke, so the man had a new one installed. Last month, the blade broke, and he replaced that as well. Systematic logic dictates that the ax is no longer the grandfather's ax, while systemic thinking maintains that it still is for the man and anyone that appreciates the narrative, symbolism, and meaning shared concerning the whole. Systematic logic approaches reality analytically, where clearly the individual components of the ax are no longer that of the original, while systemic logic considers beyond any attempt to isolate or reduce a system into subordinate parts to derive explanation.

Systems are recognized in their whole forms in perpetual integration with even more systems, and "not as a conglomeration of parts."[78] Systemically, the man interprets meaning, values, beliefs, and socially constructs symbols that transcend the components of the ax itself.[79] Systemic logic appreciates culture, organizational and institutional beliefs, and other abstractions that tend to be dismissed by those fixated on objective, analytical optimization over all else. Systematic logic provides deep description and deduction of tangible things in reality, but systematic logic is unique for humans in that they can imagine novel combinations and even conceptualize what does not even exist. Systems theorist Gharajedaghi summarizes this with:

> Image building and abstraction are among the most significant characteristics of human beings, allowing them not only to form and interpret images of real things, but also to use these images to create images of things that may not exist. These images are then synthesized into a unified, meaningful mental model and eventually into a worldview. Man feels hunger, observes the fleeing prey, and realizes his inability to capture it. After discovering other related objective realities (wood, stones, etc.), he thinks about and eventually creates a subjective image of a tool, one yet to be, that would help him secure food. Transformation of this subjective image into an objective reality results in the bow and arrow, which in turn will be a reproducer of yet another image, and so on. This dialectic interaction between objective and subjective realities lies at the core of a process called *design thinking,* which is responsible for the dynamic development of human societies.[80]

Taking a systemic view of reality and complex warfare requires one to consider many different disciplines, areas of knowledge, and concepts so that in abstraction, a broader yet more explanatory appreciation of the world is gained. This indeed is the only way a space domain might be designed and appreciated for space warfare applications. Wylie attempts a systemic framing of terrestrial military strategy by considering continental theory nested in Jomini, Clausewitz, and their successors, maritime theory framed first by Mahan and then more extensively by Corbett, and air theory based partially on Douhet. Wylie then includes a Marxist derived form of guerrilla warfare paired with Mao Tse-tung and subsequently Ho Chi Minh, Fidel Castro, and Che Guevara. He then includes the indirect strategy of Liddell Hart and attempts to systemically form a general theory of military strategy across multiple domains, belief systems, and a cohesive form and function of war writ large.[81] Wylie's systemic framing of military strategy attempts to avoid systematic logic, thus the ten-

sions between a Clausewitzian continental war theory and that of Mao's Marxist guerrilla theory are appreciated, but one is not discounted for the other.

Systemic thinking is necessary to consider what the space domain is and how it is interrelated structurally with other domains and war processes exercised in space or outside of it. Yet Wylie also partially falls into the systematic logic trap by suggesting that aerospace and space technology in the 1950s might require an extension of air theories into space for warfare.[82] The space domain, as a supra-global plane that encompasses Earth and all other celestial bodies, requires a systemic framing for space warfare in that such complex warfare will involve form and function of the space domain itself, other domains, and in a larger multi-domain systemic interplay, new manifestations of complex warfare that do not exist independently within a single domain.

As an example, the fusion of space, cyberspace, and special operations in certain security applications is offered for such a systemic treatment. These three modern war enterprises are difficult to force into the traditional, geographic and domain specific (hence systematic) military theories for continental, maritime, and air strategies. The space domain has already been defined thus far, while cyberspace is an artificial, technological creation of humanity where war now extends in virtual, simulated, and nonlinear phenomena. Special operations are a function of a unique military force and occur across all domains, yet the interplay of special operations with space and cyberspace provides systemic opportunities otherwise impossible to achieve.

The space domain, supra-global and encompassing, provides persistent and cohesive effects depending on the technology, access, and location of spacecraft. Today, nations or companies that invest heavily into constellations can monitor a single point on the planet at an incredible level of granularity and measurement, while other craft in different orbits can monitor entire continents and portions of the planet at a higher order of abstraction. Cyberspace is not akin to physical space (whether terrestrial or celestial), yet for cyberspace to exist, it has a foundation of physical artifacts anchored in some other domain such as server farms on land, fiber optic cables along the ocean floor, and Wi-Fi radio waves moving in frequency bands through space and the atmosphere.

Cyberspace itself is vulnerable to attack within the domain through hacks and other activities, and also indirectly through physical domain targeting of any systems that sustain cyberspace. Yet the notion that cyberspace has no space is perplexing for humans accustomed to physical domains in part due to thousands of years of evolutionary conditioning. The difference is that sending a letter in the mail requires physical movement of that artifact through reality in time and space. E-mails, tweets, and social media updates do not travel in this fashion.[83] Space and its supra-global form, along with cyberspace

and how it is a digitally created virtual domain unlike physical ones render both as dissimilar to the traditional, terrestrial domains for security affairs.

Mission command, as a philosophy and a process for rapid military decision making, seeks a systemic over a systematic approach in complex warfare. The US Army's *Functional Concept for Movement and Maneuver: 2020–2040* emphasizes the importance of decentralized maneuver and systemic application of force. This "achieves surprise and gains a temporal advantage. The aim is to shatter the enemy's cohesion . . . avoid enemy strengths [and] attack enemy weaknesses from multiple positions of advantage throughout the depth of the battlefield. The ultimate goal is panic and paralysis."[84] This cannot be accomplished in any purely systematic manner and must occur systemically across multiple domains including the space and cyber domains.

Cyberspace will play an increasingly larger role due to technological developments, human investment into more sophisticated virtual and augmented realities, while the space domain also will become a primary if not central domain for such systemic military actions to be exercised. Traditional, centralized hierarchical forms of control and mission execution favor systematic, reductionist, and linear-causal conditions which will no longer be prominent or possible. Far flung spacecraft will work in decentralized ways, primarily within a mission command style that must be integrated systemically into many different activities in cyberspace or where special operations are occurring.

Such future warfare may take on a *phantasmal* configuration, one that paradoxically features both a real and a false manifestation with one foot in the physical reality of tangible military domains (air, land, sea, and space) and the other in the abstract, socially constructed reality comprising human (and likely artificial intelligent) minds and cyberspace. This new suggestion of a phantasmal war is one that the space domain in conjunction with cyberspace and certain special operations activities is uniquely primed to bring into reality. Sigmund Freud and Pierre Janet first proposed the notion of false memories, which in contemporary society has been captured in what is called "The Mandela Effect." Fiona Broome coined this term where many people falsely remembered Nelson Mandela dying in a South African prison in the 1980s. There are many examples of this where people insist on false or entirely imagined facts, stories, and events that never occurred. While such distortion and misdirection originate in the earliest terrestrial domains for warfare and Sun Tzu's emphasis on cunning, misleading military activities, the phantasmal war construct approaches an other-worldly development in future potential conflicts with space, cyberspace, and special operations.

Space effects are often framed in reversible and non-reversible terms, where a spacecraft might blind or otherwise inhibit a space or ground system without

damaging it. Such space activities are reversible and are intended to be a part of deterrence but also be factored into actual warfare where the destruction of a spacecraft (nonreversible) comes with second-order effects such as a debris field, orbital obstacle, or other fallout from the attack. Cyberspace presents a similar configuration with reversible and nonreversible cyber-attacks with worms, viruses, ransomware, and other hacking.

Cyberspace and space domains overlap with special operations in how some activities are conducted clandestinely and others are covert. Clandestine effects are not detected by the adversary, in that success in such a cyber, space, or special operations mission means no one noticed that it happened. Covert operations, whether in a terrestrial domain, cyberspace, or space are noticed, but the victim should not be able to determine who did the activity. These operations and effects are already well understood in modern warfare, but the rise of a phantasmal war takes these real activities and effects and blurs them with false or fantastical effects across cyberspace, space, and to a lesser degree, terrestrial domains where an act of organized violence might not ever have occurred, but people believe it did.

Systemically, these future war effects can be accomplished through multi-domain, multi-disciplinary, and tangible with intangible activities. The supra-global nature of the space domain has vast celestial impacts, and as societies increasingly are dependent on space for information flow, access, and vast expansion into colonizing, energy, and economic developments off planet, systemic military activities will center on the space domain in new ways. Reversible, nonreversible, clandestine, covert, nonattributable, and various combinations therein will be capable in tangible, explicit military actions across multiple domains but also in purely socially constructed ways that can be illusionary, false, or distorted. An entire war might occur in phantasmal fashion, where populations and leadership are targeted to imagine a false representation of a conflict that either did not occur as they believe it did, or it did not occur except in their fantasies. This can be exercised in the interplay of multiple domains, particularly through the unique properties and capabilities of space and cyberspace. As new technology advances what is possible in space, cyberspace, and into individual and collective social constructions of reality, these relationships will tighten further, but also open unimagined possibilities for real and phantasmal warfighting.

The space domain, as a supra-global one, will expand fantastically in the coming decades and become an ever-increasing primary domain for security and warfare. Future space domain and technology might usher in a world where no matter what human, what location, they are being observed or collected on in real time by space systems, and while no such system is ever

perfect, the degree of data access and speed will be unprecedented. Human decision makers, whether in a terrestrial domain or in space, may become too slow to be anything but a hinderance in critical warfighting activities where AI alone can sense, decide, and respond quickly enough.[85]

Even if a person attempted to "go off the grid," merely stepping outside or entering any location with any technology and data collection would still locate and collect on them. Overt and direct offensive activities would be different in such a hyperconnected, systemic framework for various high technology rivals, and the space systems providing such capabilities would become paramount in multi-domain security affairs. For example, the German surveillance company FinFisher clandestinely aided the Bahrain government during the Arab Spring movement between 2010–2012. FinFisher installed spyware on 77 computers, giving that government remote access.[86] This enabled the government to crack down on the protests, even targeting organizers through hacked systems. Even at significant cost and intensive labor, the FinFisher example is just the beginning of what can be upscaled and systemically enabled across the space and cyberspace domains in tandem, where instead of 77 computers, 77 million computers (or 77 specific targets within a 77 million accessible network) might be collectively monitored, infiltrated, or disabled.

Currently, spacecraft are essential for early warning of missile activity, various high priority intelligence, surveillance, and reconnaissance targets, weather, and other capabilities that are expensive and prioritized. Despite conspiracy theorists and paranoid individuals, existing space systems are incapable of monitoring or targeting individuals unless they are a high value target for a nation's defense or intelligence agencies. Yet the future space domain may flip this into a reality where every single human (and likely any similarly capable AI systems or robots) is perpetually in a space and cyberspace system of monitoring and collection in real time. Further, those humans heavily integrated into augmented or virtual reality will face additional security requirements (and vulnerabilities) through space and cyberspace due to their unique data associations.

Today's space-based offensive suite of options is likely dwarfed by the emergent ones of tomorrow, where lethal and nonlethal effects might conduct reversible and nonreversible actions covertly, clandestinely, or overtly to virtually any person, group, organization, or even a society. Militaries today engage in systematic logic to target one thing, person, or desired effect to specific inputs and outputs. The future space domain should offer a transformative shift to systemic logic where entire networks, populations, relationships between actors, information, and even various interpretations of meaning and identity

across such systems are targeted, manipulated, or shaped through perpetual and pervasive space and cyberspace systems.

Breaking a Domain: Future Space Wars that Disrupt Everything

Advocates of space warfare point to the need for robust space doctrine, strategy, and how space superiority should extend beyond deterrence into any actual conflict through conclusion. Space is unique from most other domains in that it has developed militarily with hardly any human military members in space itself. The space domain is further unique in that the first significant space conflict may also be the last, in that such a war could "break the domain." In the early 1960s, the Soviet-American nuclear race nearly did so to low earth orbit, with acts like the American nuclear test of a 1.4-megaton Starfish Prime launched in the Pacific that created such EMP emissions that it disabled multiple satellites in LEO and threatened the health of future human spaceflight projects.[87] Today's advanced nuclear systems and the congested orbits full of multinational, commercial, and scientific systems make the destruction of the space domain a possible and dangerous outcome. This complicates the question over what sort of doctrines and strategies are feasible, universal, or limited and potentially for "one time use" only. To illuminate these tensions, a quick summary of how deductive, inductive, and abductive logic work is necessary.

Deductive reasoning validates inferences when the conclusion follows logically from its premises; deduction starts with general rules and establishes specific conclusions that are universal and consistent. Sherlock Holmes applied scientific reasoning to crime by using deductive logic to understand what otherwise seemed mysterious. Holmes approached a crime scene armed with his deeply studied knowledge base and assessed the specific, contextually unique crime facts. He would then issue his verdict, deducing how things occurred in that this specific criminal mystery could be unraveled using a body of scientifically structured rules and formulas. Much of modern military theory on warfare, decision making methodologies, and military doctrine rest upon similar deductive reasoning. Jominian principles of war work in this fashion, as militaries take the specific and current conflict (the now) and apply general, universal tenets to establish linear-causal, deductive logic assertions. The more a military builds historical case studies of deductive warfighting logic, the deeper it becomes institutionalized as a fundamental truth about warfare.

Inductive reasoning differs from deductive reasoning, in that the conclusions of induction are probable, while those of deduction are supposed to be certain. Induction works where the general principles are derived from the individual

or specific observations. Unlike how Holmes solved crimes, scientists begin not with generalizations but specific samples and isolated parameters so that observations can be made on the specific. Once done, those observations prove or disprove a hypothesis, which then provides probable conclusions for applications beyond the specific sample. Militaries also rely upon inductive reasoning, such as when several infantry units in the al Anbar province in Iraq observed a reduction in Sunni militia attacks after creating defensive security coalitions with tribal sheikhs and former Ba'athist Iraqi Army leaders. Coalition leadership subsequently directed that all units in Iraq seek out Sunni tribes and partner with them to oppose the foreign al Qaeda terrorists. Inductive reasoning is also found where militaries dig wells, build schools, and pave roads with the expectation that performing these infrastructure and governmental actions should increase security and prosperity, regardless of location, culture, or conflict. Military theories, methods, and processes that espouse "best practices" and universal formulizations are usually deductive, while "good enough" practices and broader, flexible warfighting constructs tend to illustrate inductive logic. Modern militaries make sense of complex warfare and the primary terrestrial domains through combinations of deductive and inductive logic.

Abductive logic differs from both of these and is not readily observable in modern military doctrine or practice. Abductive logic works best in complex or even chaotic systems, where a multitude of emergent, nonlinear, and systemically transformative activities prevent a conclusion from being positively verified. Abductive reasoning makes probable conclusions based on existing knowledge that is incomplete, coupled with the understanding that complex systems are dynamic, often learning as we engage within them. Gharajedaghi, in explaining nonlinear systems, provides a useful example of where abductive reasoning would become essential within a complex system setting: "Analyzing the behavior of a nonlinear system is like walking through a maze whose walls rearrange themselves with each step you take (in other words, playing the game changes the game)."[88]

Deductive logic requires the game and the maze to remain forever fixed, so that once a player learns every configuration of all possible mazes, they need only deduce which maze they are in so that they can readily provide the best path out. Holmes would call this elementary. Inductive reasoning would apply tested techniques for navigating mazes and apply them toward any newly discovered maze so that the techniques are tested and improved upon. Unfamiliar mazes could be studied and outdated or obsolete hypotheses validated in earlier mazes could be curated and adapted as new understanding emerges. Abductive reasoning would apply in Gharagedaghi's example, where complex, dynamic systems resist ever cooperating in ways that cede advantage to deduc-

tion or even induction. If a living, cunning, learning adversary within a complex, dynamic system seeks to design and implement systemic changes, our own logic requires similar flexibility and improvisation. Abductive logic involves "thinking about one's thinking" while in action in an ever-changing context.

Deductive, inductive, and abductive reasoning were presented here to establish a difficult argument concerning future space warfare and the institutional interests in creating space doctrine. Military forces that deal specifically with nuclear warfare and space warfare share something in common that all traditional, terrestrial military forces do not. For the US Department of Defense, these arguments on doctrine and lessons learned relate to US Strategic Command and US Space Command. Land, air, and sea forces establish historical precedence and cumulatively build military processes, methods, and doctrine through exercising these ideas in various conflicts. They extend concepts that appear universal and robust through deductive logic, while introducing new technology, change, and adaptation through inductive experimentation.

Land forces continue to use centuries-old concepts such as center of gravity, level of war, or principles of war because in each conflict, they continue to realize patterns that reinforce such concepts through deduction and induction. Even when armies are defeated, they continue to use and refine much of the doctrine, ideas, and beliefs that remain significant to that force's identity, form, and function in war. The US Army in the Post-9/11 conflicts in Iraq and Afghanistan used much of what had previously been used in the Vietnam War, in terms of theory, methods, doctrine, and practices.

First, nuclear warfare provides important clarification for why the space domain and space warfighting organizations require careful and distinct understanding of what doctrine is, and what it is not. Excluding the first atomic bombs used to end World War II, no nuclear war has happened between two or more adversaries, particularly superpowers capable of destroying human civilization in such an exchange of organized violence. This means that any nuclear doctrine or strategy cannot be positioned in the same standing as knowledge from traditional, terrestrial military forces. Nuclear strategy and doctrine might have technological and possibly tactical or localized content of high value, but the strategic-level material can only be abductive, and applicable for some one time-usage, if that. Rapoport frames this as such:

> Loss of contact with reality is especially evident in "doctrines," which are supposed to serve as guides in constructing strategies involving the use of nuclear weapons. Here loss of contact with reality is inevitable, since whatever relevant experience may have guided the formulation of "classical" doctrines [land, sea, air forces in conventional warfare], *no* such

> experiences are available as guides to nuclear strategies. Moreover, since nuclear wars can hardly be expected to occur repeatedly, whatever experience is gained in the first (and very likely the last) nuclear war would be of questionable value to survivors, if any.[89]

Nuclear warfare and the deterrence of such a type of conflict is intricately woven into modern space defense operations. Any attempt for a "first strike" using nuclear weapons would necessitate offensive actions in space to reduce or eliminate opponent situational awareness and detection abilities, thus slowing their response or counterstrike. Space warfare would potentially be the first act in what would tragically become some nuclear conflict of mutually assured destruction. This puts US Strategic Command and US Space Command in similar company. Nuclear strategic doctrine is hypothetical and only explicit and objective in technical and scientific terms. Some operational and tactical doctrine appears relevant in both space and nuclear weaponry, but the nuclear military context differs from space domain considerations in one additional way.

First strike of nuclear weapons in terrestrial effects forms much of how deterrence and nuclear defense is rationalized, yet scientists studying space security for the American Academy of Arts and Sciences concluded that "being the first to deploy space-based weapons would not confer a significant or lasting military advantage."[90] Aside from breaking the space domain for humanity in such strategies, first offensive strikes in space suggest yet another way in how Clausewitzian emphasis on offensive destruction at some decisive point may remain largely a *terrestrial* strategic belief. Additionally for nuclear and space strategists that seek game theory to enable complex simulations, mathematical approaches reliant on thousands of iterations to generate mass patterns will also fail in both nuclear and space contexts. Each instance of nuclear or space war are "one time only" catastrophic events. This prevents game theory from gathering the essential meta-data in that unlike terrestrial wars (not involving nuclear exchanges), the individual events of nuclear or space war terminate the game, or perhaps destroy the system that the original rules and premises relied upon. This is akin to a gambler with their entire life savings betting on one number on the roulette wheel, thus playing only one possible time.

Policy makers and strategists cannot assume any nuclear, and by extension space warfare doctrine to be grounded in any historical, deductive, or much inductive logic other than what likely is available to all state actors already. Should a space war occur (and potentially move quickly into nuclear escalation), the conflict would become a one time, unique, domain-killing event. Just as there would be few useful lessons for survivors of a nuclear exchange, space

organizations would find little comfort in doctrinal revisions after a catastrophic space conflict. Notions of space superiority and space dominance are only applicable in deterrence and in the early stages of any kinetic activities, such ideas would quickly become irrelevant, or obsolete. Even with superiority of one's own space systems after the first strike against a near-peer rival, the destruction and debris might make such a position fleeting, or even counter-productive, depending on the manner of kinetic action and space domain effects.

Even the concept of space control is problematic, in that throughout the Cold War, neither the American nor Soviet forces could ever argue that they alone controlled space in a manner that suggested dominance over a rival.[91] Space today is far more crowded, with the cost of launch and space technology plummeting, the number of national and corporate space actors skyrocketing, and the sophistication of space military abilities suggesting that any offensive activities in space may only permit temporary, fleeting windows of space superiority or dominance, if any at all.[92] Militaries in terrestrial contexts may control a specific location, or control an area for a particular time, but the physics of the space domain make such ideas difficult to directly extend into celestial strategic thinking. One might control an orbit through first moves or remove competitors from operating in that orbit through attrition or make that orbit unusable for humanity. In commercial space applications in the future, a military might temporarily rent control by purchasing sufficient time, information, or perhaps spacecraft abilities in a conflict with rivals. Conversely, advances in technology may transform how future militaries understand how the space domain might be controlled for strategic advantage in ways that are too fantastic today to seriously consider.[93]

One additional way the space domain shares war phenomena with the nuclear era of modern complex warfare is how limited conflicts between nuclear peer adversaries presents a curious overlap. Since the 1950s, the United States and allies waged a Cold War against the Soviet Union and their allies that positioned multiple limited engagements within an overarching strategy of nuclear deterrence. From the 1950s through the late 1980s, both sides sought to gain strategic advantage without triggering a full-blown nuclear conflict by engaging in limited wars that frequently featured tactical events which were directly influenced by these larger nuclear strategic goals. In other words, each side would accept far more tactical defeats, at costly levels well beyond pre-nuclear engagements, so that certain conditions would not pressure some more devastating reprisal. Henry Eccles discussed this in 1957, sharing a quote from James King, Jr.: "Moreover, we must be prepared to fight limited actions ourselves, otherwise we shall have made no advance beyond 'massive retaliation'

which tied our hands in conflicts involving less than our survival. And we must be prepared to lose limited actions."[94]

Extending this into the space domain, will the devastating consequences of total space warfare, conflict that destroys low earth orbit and likely any future possibility for humanity to return to the stars, generate a similar deterrence factor that forces spacefaring peer adversaries (whether with or without nuclear parity) to accept tactical defeats in limited conflict to avoid the mutual destruction of space? Removing nuclear weapons from the discussion for a moment, the emergence of the space domain brings forth unprecedented technological capabilities, information, wealth, and power through free, unfettered access to the space domain. Any high-intensity space warfare would feature catastrophic destruction of not just military spacecraft, but commercial and international systems including the economic, informational, and political fallout of such acts. The likely consequences of such an engagement would feature dangerous debris fields, and possibly radioactive clouds in the upper atmosphere or low earth orbit that would likely deny any future space access without significant resources and new technology.

Simply put, the space domain shares multiple parallels with nuclear deterrence strategies in that space is already so valuable that spacefaring peer rivals may have their hands tied twice. The first may be tied in the traditional nuclear format that forces limited wars, proxy wars, and other activities below the threshold of mutually assured nuclear conflict. The second may now have a second tight binding that pairs limited activities in space to any future conflict due to the mutually assured destruction of the space domain for both parties (and all other parties). What is interesting in foreign policy and national strategy is whether new combinations of all-domain deterrence become additional factors in future conflicts, where perhaps a non-nuclear rival that does have spacecraft offensive abilities could assume similar deterrence abilities and force the acceptance of greater tactical defeats in new limited wars against an adversary with both nuclear and space capabilities. A nuclear capable nation that lacks significant space capabilities might do the inverse, forcing tactical defeats in limited wars against a spacefaring rival that cannot risk destruction of the space domain, even if threatened by a weak nuclear power with no spacecraft or space abilities of their own.

The space domain thus is a new and different plane for human existence, exploration, development, and conflict. This domain is not merely some projection of a terrestrial domain just because certain phenomena overlap, such as the drift of the seas and celestial drift. Some of these overlaps appear valuable, but they should not be taken wholesale as "space equals X." Nor should tensions be ignored, where the space domain presents dissimilar and potentially wildly

novel circumstances that are unprecedented in any terrestrial, historical sense of warfare. It is in the interplay between domains, societies, cultures, organizations, and a systemic framing of all-domain, complex warfare where the paramount issues are illuminated.[95] Space has some conditions and characteristics that require consideration of nuclear age strategic thinking, and overlap with multiple terrestrial domains. The space domain is vast, powerful, yet fragile, and increasingly at risk for domain destruction (if only to isolate the human species to their home planet). These matters impact all humanity and have been presented at a necessary level of abstraction to frame the political, national, and international challenges. We next need to dive back down into the individual human and how the space domain challenges how we typically make sense of reality on planet Earth.

Human Experience of Time/Space Differs Off Planet

Historically, humans engaged in war for millennia in limited, frequently localized, and unavoidably tactical planes of existence. Until modern, industrialized, and nationalized wars started in the Napoleonic era, a well-timed tactical battle might accomplish strategic goals immediately.[96] Heroic leadership alone, or the individual symbolic victory of a knight in ritualized combat could complete all war aims, while inclement weather or the arrival of harvest could quickly quash military campaigns. War originally occurred in a highly localized, limited fashion, where violence extended only as far as the voice of a commander, the signal flags of his forces, and the projection of an arrow via the animal sinews of a bowstring might reach. War was experienced in the traditional terrestrial domains comprising land and sea, with air a far more limited plane of war experience until recently. People understood warfare effects in these initial and primary domains, and how war would be exercised would be further defined in the localized time and space of the immediate/tactical. Prior to technological developments in communication and movement, battles routinely occurred well past the signing of treaties ending a conflict, like the Battle of New Orleans in 1815 which occurred over two weeks after both parties signed the Treaty of Ghent, ending the War of 1812. Word traveled as fast as war could.

Up to the last eight decades, war was terrestrially bound. During the three centuries prior, war moved as fast as muscle and wind power permitted. In the modernization and industrialization of societies including political and societal developments into the modern, Westphalian-derived nation-state, war expanded to vastly more complex, faster, and dynamic configurations spanning a scale and scope that required operationalization of war activities between the tactical and

strategic. World Wars spanned continents and time zones, while the rise of cyberspace and a virtual digital reality for humans have ushered in further disruption of classical, terrestrially oriented war constructs. Space is one of those profound developments, where humans now enter a celestial plane of warfighting experience that does not merely extend the bounded terrestrial accordingly.

Time zones work with respect to the planet and how people must adjust activities dependent upon how fast they depart one localized area and enter another. Coordination of military actions without such concepts would be impossible, and once introduced into the legacy frame for how war used to be in pre-industrial periods, militaries needed to think differently. This now awaits militaries entering into the space age, and the integration of the space domain into future conflicts. Indeed, time and space itself is largely interpreted using the Newtonian laws of motion, while Einstein's special theory of relativity previously had little relevance to modern military affairs. The space domain changes that, particularly due to the vast size and ever-expanding significance of space that is based upon how far and technologically capable humanity can extend.

The International Space Station currently uses Universal Coordinated Time or Greenwich Mean Time while in orbit around the earth. Beyond that, events that occur locally at the spacecraft, probe, or satellite is termed "Spacecraft Event Time," while another method of measurement and time is "One-Way Light Time" for how long a signal takes to go from the spacecraft to Earth.[97] Time on other planets works just as on Earth, meaning that a Martian day lasts 40 minutes longer than a day on Earth, and while scientists project GMT from the Earth upon the Moon, physically people on the Moon experience time slightly faster due to a lesser gravity field (and a lunar month is 29.5306 Earth days). Europa, a likely future colony option and a source of water, spins once on its axis every 3.5 Earth days. Celestially, time is relative and dependent upon physical forces that require different coordination efforts than even the most dynamic of terrestrial security affairs. This involves time dilation, which in almost all terrestrial applications and most of military history is an insignificant or irrelevant concern.

The space domain today does have time dilation concerns (the difference in elapsed time as measured by two clocks in two different locations), but these deal with fractions of seconds between the surface and spacecraft or personnel in orbit. As humanity expands into inner solar system colonization, exploration, and economic development, time dilation will become increasingly significant for mission planning, situational awareness, and mission command of multiple forces spanning a domain that dwarfs contemporary geographic combatant commands. As technology increases the speed and reach of human presence in space, some matters previously in the realm of science fiction will

become real matters of concern for space military commanders. Interestingly, many of the past challenges in preindustrial and early steam engine periods for war will return.

While information currently speeds around the globe near instantaneously, this is a high-technology, terrestrial benefit to well-resourced military forces and even low-tech adversaries able to access commercial hardware. Nearly everyone can communicate globally, and despite the best efforts of many nations, nearly anyone can broadcast from within the most isolated areas of the planet onto the global commons, often anonymously. A multi-planetary species with human occupation across the inner solar system and intelligent, even autonomous space machines even further afield will require new ways to organize and orchestrate multi-planetary space defense strategies. The laws of physics and celestial mechanics cannot be broken, nor ignored. Technology will of course aid humanity in many of these new challenge areas, but they also will illuminate the ultimate limits that celestial warfare must adhere to.

Mathematically and technologically, the integration of celestial war activities could nest with assumed terrestrial ones, if all-domain, complex warfare continues as anticipated. However, the current physical barriers of space suggest that future Battles of New Orleans may occur, in that directives and information cannot move celestially as they might terrestrially. Clearly, synchronization of military systems, people, and resources across a space domain involving multiple terrestrial domains (even limited to the Earth and Moon) demands new ways to form strategies, make decisions, and adapt to changes. When such decisions are made, who makes them, and how the consequences of those decisions impact the rest of a celestially and terrestrially distributed military organization suggest profound transformation is ahead. Humans today are predominantly on Earth, and humans in space remain fragile and in extremely small (and arguably nonmilitary) contexts.

Thus, human decision makers on Earth will remain bound to the speed of information in space unless they delegate certain decisions to autonomous artificial intelligence systems in spacecraft with military capabilities. This is not new in warfare, as modern nuclear submarines operate with clear orders and engagement directives that do not require direct contact beyond the ship leadership. The Soviet Union's political and military leadership during the Cuba Missile Crisis already granted tactical commanders on the ground the ability to decide to launch short-range, tactical nuclear weapons independently.[98]

Not only does the space domain dwarf all historically understood terrestrial domain challenges of time and space, but the localization of human decision-makers in future space conflict transforms the severity of warfare consequences. Hypothetically, a rogue Soviet commander could have launched a single nuclear

warhead and obliterated Miami in 1962, potentially triggering World War III and ending human civilization as we know it. Nuclear deterrence continues through today without a single offensive launch of a nuclear weapon largely because nuclear adversaries consider their rivals in rational actor, humanistic frames. This reinforces Clausewitzian war logic that, given the complete destruction of an enemy military, society ought to lose the will to resist, in that they should collectively rationalize that they are defeated.

Yet future space weapon systems and spacecraft will likely be increasingly devoid of human decision makers. Artificial intelligence and technologically enabled machines are a cheaper, safer, and more sustainable alternative for commercial and military actions in the space domain. This suggests that some nations may grant a wide range of offensive, lethal abilities to an AI system, making autonomous weapon systems in space able to act independently and rapidly over any opponents that maintain a terrestrial inspired, human-centric form of decision making. Those nations that place greater reliance upon autonomous weapon systems face ethical, legal, and moral obstacles, but these all might be irrelevant in a future high-intensity conflict involving the space domain. Most terrestrial domain warfare centered historically on humans, with decisions and activities arranged in time and space upon frequently localized or proximate relationships.

Recent multidomain conflicts such as the Russian-Ukraine War reflect human-machine teaming as an emerging and significant development.[99] Yet celestial decision making in future war may take on a hybridization or even a polarization where humans make certain decisions while autonomous artificial intelligent systems decide, communicate, and act outside of human direction.[100] Consider an autonomous weapon system in orbit around Mars that independently acts, but this event occurs before it receives new and significant guidance on conflict resolution by human leadership on Earth. In a telling engagement in 1958, the US Air Force fell into this trap of attempting to conceptualize celestial war strategy using terrestrially familiar frameworks. Moltz summaries the public exchange with:

> Lieutenant General Donald L. Putt of the Air Force gave a speech in early 1958 in which he called for establishment of a US missile base on the Moon to fire nuclear-tipped rockets at the Soviet Union in the event of war. But scientists such as Cal Tech president Lee DuBridge fought back, countering that "if you did launch a bomb from the moon, the warhead would take five days to reach the earth. The war might be over by then." General Putt's proposal quietly died.[101]

Celestial time and movement occurs differently and on vastly different scales than any terrestrial domain for military action. Even if Putt's idea of a Moon missile base were taken seriously, it could only work as a "dead hand switch" nuclear deterrence option such as the Soviet designed automatic nuclear weapons control system that would launch after an enemy nuclear strike was detected. The "dead hand" would retaliate, ensuring mutual annihilation to all parties. Such a weapon could be positioned on the moon or on a station in geosynchronous orbit, but the costs and practicality of such a device appear unfeasible to terrestrial options. The logical errors that the 1950s Air Force committed were due to this institutionalized tendency to extend terrestrial war conditions, concepts, and methodologies upon the space domain without realizing how different space is. These patterns of poor correlation in war strategizing are not limited to the 1950s and continues to this day across most western military forces and among policy makers.

Space as a celestial medium differs from terrestrial domains in a range of physical ways that may be in tension with how humans historically interpret how warfare occurs. Land, air, and sea domains are Earth-specific, while future militarization of other celestial bodies will create unique conditions such as lower or higher gravity fields, lack of atmosphere or the presence of different conditions, and logistical considerations that suggest new strategy formulation for space domain contexts. Many of these are mere technological or mathematical considerations, but nonetheless require military consideration. Naval vessels do not expend most of their fuel to escape safe harbor, and aircraft act in similar fashion in the air domain. Spacecraft, however, invest the bulk of their fuel to escape the Earth's atmosphere, and require minimal fuel expenditure once in orbit or beyond the planet. Positioning space resources beyond the terrestrial limits is already an understood strategic focus area for spacefaring nations, with the Lagrange points becoming increasingly important for military and commercial applications.

The concept (and philosophy) of "Mission Command" is yet another area that suggests a different manner of military application within the space domain. Joint Publication 3-0 defines it with: "if a commander loses reliable communications . . . *Mission command*—a key component of the C2 function— . . . enables military operations through decentralized execution based on mission-type orders."[102] The space domain, as a supra-local plane of human existence, will expand perpetually with every new accomplishment by humanity in space. This means that, over time, the space domain and the military forces responsible for security and defense of humans, resources, and key terrain within space will face an ever-expanding outer boundary.

This again returns to the celestial challenges of time, distance, and knowledge versus that of terrestrial military contexts. The laws of physics may bend, but they cannot be broken, and hypothetically even light-speed communications will take significant time for cislunar and especially inner solar system dispersed forces. The space domain is perhaps the ultimate context for mission command execution, in that commanders of spacecraft or the artificial intelligence systems programmed and directed by humans will encounter developments and opportunities that were not anticipated even by the best space strategists. Space forces flung across deep space will face military challenges that cannot be slowed down or halted until new guidance is requested and then makes the celestial round trip with new directives. Russell Glenn said, "The sergeant leading his squad sees what his platoon leader cannot," and in space this gap in awareness is stretched to scales difficult to imagine in historical settings without going back to the days of wind and muscle power.[103]

Within space applications of mission command, the responsibilities of those human commanders or any autonomous weapon systems will require deep preparation—whether extensive training and education for the humans or sophisticated programming and code for the AI systems so that decentralized, creative, and improvisational military choices can be conceptualized and put immediately into action to accomplish the original and broad intent of the higher command. Space weaponry will likely be destructive on celestial scales where the effects of kinetic and even non-kinetic actions may involve the lives of millions, resources valued in trillions, or in long-term consequences that alter the balance of power on a cosmic scale. This also bends, if not breaks, the original terrestrial design for mission command.[104]

For the US military, use of weapons of mass destruction cannot be decentralized, and organizations must delineate between what responsibilities, missions, effects, and level of control can be adapted to the mission command philosophy of deviation and emergent improvisation at the decentralized edge of battle and what must remain wedded to clear, centralized authority and control. The steep hierarchical structures developed in twentieth century warfare are increasingly fragile today, and the space domain will ultimately break us of those old habits. The space domain as it expands beyond low earth orbit will not allow anything but decentralized mission command.[105]

The implications here are vast and must be applied both to future human commanders in deep space, the human-machine teaming configurations, and to autonomous weapon systems operating at great distances from any human awareness and control. The explicit knowledge, of course, will be clear and objective. The tacit knowledge necessary for mission command in these complex, celestial security challenges will not, and likely the level of human and

machine development will be steeper than the speed at which humanity expands across space and builds ever devastating space weaponry.[106]

Defense Above National Conflicts: Species Preservation in Space Activities

Terrestrial domains historically define war. Premodern societies through the Feudal Age waged limited contests, often within strict ritualized rules and norms (but not between different cultures), where the strategic goals of seizing new land, resources, and populations were accomplished in deliberate tactical activities. Defense of one's nation would become a modern, Westphalian construct but was still defined by military forces securing borders on land, coastlines, and significant waterways over sea, and in the twentieth century, the control and defense of the air domain associated with national security interests. In each of these contexts, ancient Greek mariners and American strategic nuclear bombers in the Cold War sought to prepare and inflict destructive acts of organized violence to defend and protect national interests that directly nested in a terrestrial domain. The space domain does feature this in that spacecraft orbiting over a nation represent security capabilities or threats, depending on the owner of the system and purpose of it. Yet low- and mid-earth orbits mean that spacecraft must move over many other nations in space, and the already discussed unique characteristics of the space domain alter many traditional frameworks for defense and security on land, in the air, and at sea.

Much discussion on the space domain and space security affairs orients on competition, deterrence, and state-on-state challenges, with rising concerns of nonstate actors, commercial, and civilian activities in the space domain. This indeed is human-centric, and terrestrial centric in that such conflicts would demand multidomain action where space systems support or act with land, air, sea, and cyber forces against a defined human threat (person, group, or nation). However, as a species, we are the first and only to be able to manipulate reality so that they can escape the planet, interact in the space domain, and ultimately alter what had previously for all other living creatures in existence been a cycle of creation and destruction on a cosmic scale.

For the entirety of Earth's existence, this planet has faced bombardment by asteroids and other objects that both created the possibility of life on the planet, and on many devastating occasions, wiped most of that life off the planet. Existential threat has been an ever-present phenomenon to living beings on Earth. Approximately every 50 to 100 million years, the planet is struck by a large enough object to essentially reset the ecosystem and, in the case of the

dinosaurs some 65 million years ago, end the dominance of one form of life to open up the emergent potential of another.

Moltz, in quoting scientist Donald Yeomans, describes this with: "Earth runs its course around the sun in a cosmic shooting gallery—with us as the target."[107] Today, humans are theoretically capable of destroying these extinction-size celestial threats or altering their trajectory in the space domain, given sufficient technology and time. Multiple space agencies and governments continue to develop contingencies to confront this threat, and if such a security challenge were to arise in the coming decades, it would likely be well within the space security forces' capability to detect, decide, and act (likely in conjunction with industry and other nations) to defeat such a threat.

The space domain differs from terrestrial ones in this additional regard, in that terrestrial acts of natural disaster are localized to that area and population, whether an earthquake, volcanic eruption, or devastating act of weather. Space-based threats loom over the entire planet, and if a large enough object is projected to enter the atmosphere anywhere on the planet, the devastating effects will impact all nations, independent of size. This poses several new and interesting ethical questions for military forces operating in space. Space-based objects threatening the planet must be defeated whether they directly threaten one's own nation, or any other nation, including rivals and even outright enemies possibly engaged in a conflict. Should an asteroid large enough to destroy most of North Korea or Iran be detected and, on a path to impact the planet, American and other spacefaring nations in conflict (or in a future open war) with such nations would have little choice other than to stop the object in space. While taking no action might provide immediate elimination of a rival national threat such as the complete destruction of large population centers hosting the bulk of that nation in conflict, such military strategy is unethical and immoral, at least in western, liberal, and democratic perspectives. Interestingly, the act of saving a nation in such a manner might provide new off-ramps for conflict resolution, and even cultural shifts in otherwise unsolvable international gridlocks. This of course is wildly speculative and more appropriate in Hollywood science fiction narratives, but philosophically, the threat of an existential asteroid strike violates some more Clausewitzian declarations on how modern war is understood.[108]

Space forces that operate in the space domain are not only responsible for securing their nation and allies/partners against space threats that come from human origin, but theoretically are also responsible for protecting the entire species and all life on Earth from existential, alien threats at a cosmic scale. Philosophically, this transcends any terrestrial based, international conflict or cultural divides. Were the United States unable to defeat an inbound asteroid

threatening the entire eastern seaboard and a Russian, Iranian, or Chinese effort later succeeded in time, how would such actions be framed within modern military theory or models? Whether or not one attempts to defend and extend contemporary war theory to address this is beside the point.

The space domain is the only plane of human existence where such security affairs may manifest, and the celestial cycle of planetary extinction events is without question. Technological developments likely will open far more possibilities to mitigate or even solve this celestial challenge, and potentially societies might develop diplomatic and partnering opportunities where the space domain becomes one of universal space defense of humanity, beyond even the terrestrial differences and conflicts likely to continue in the land, air, and sea domains.

Conclusions: Space is the Infinite Domain of Future Security Affairs

Technological innovation is profoundly important to security affairs and national interests, particularly to ways that humans might transform current systems and war parameters into unrealized, even unimagined ones where potential advantage lies waiting. History is replete with tales of victors defeating their opponents through the application of new, devastating technology such as mechanical crossbows able to pierce a knight's armor, the belt-fed machine gun able to cut down even the most rapid infantry charge, V2 rockets raining down upon London civilians from over the horizon, or the detonation of atomic bombs over Japan. Historians even distinguish between ages and periods in how humans function as a society based on technology with the Bronze Age, or the rise of steam power or the Industrial Revolution. Yet technological advancement alone does not guarantee victory in battle to the wielder of new power. Often, cunning yet technologically inferior opponents defeat their advanced, modern military rivals using simple yet effective methods. The Taliban defeated the Soviet and later American superpowers in Afghanistan, as did the Viet Cong and partners in Southeast Asia before them. Technology in warfare is often a double-edged sword, and one that might blind the nation expecting quick and decisive results for investing so heavily.

However, Andrew Marshall, in a famous memorandum that remains valid in 2023, advised the office of the Secretary of Defense in 1993 that, "technology makes possible the revolution, but the revolution itself takes place only when new concepts of operation develop and, in many cases, new military organizations are created."[109] He went on to warn that just being ahead in the technological race and any weapon systems embodying it may be insufficient if there is not first a robust development of new concepts, new thinking about how

and why the operationalization of such new war tools might unfold, and whether current military organizations should reconfigure differently.

Marshall believed the new thinking would endure far beyond the flash of new technology, particularly in how militaries attempt to remain relevant and capable.[110] The space domain represents a new domain that will upset nearly all previous systems of checks and balances in how societies engage in politics, commerce, information curation, culture, and war. We likely will harness technological, tactical, and technical designs for space conflict well before we invest sufficient thought into the strategic, organizational, ethical, moral, and philosophical demands for us to frame the space domain beyond our legacy conceptualizations. Space warfare will differ from previous terrestrial wars, but also encompass this area in novel, unrealized configurations that integrate celestial with terrestrial.

The United States has, thus far, extended earlier nuclear policies, strategies, and military theory of the Cold War into the space domain in what appears to be a systematic logic of "previous input A leads to predicted output B." We draw from history and terrestrial constructs to develop A, and project them toward the novelty of a space domain (B) with an assumption that "A leads to B."[111] Incrementally evolving understanding in such formulaic, analytically optimized ways often contributes to a bias of expecting historical patterns to provide order, stability, and prediction to the future.[112] Since the 1950s, military, political, and technological theorists have drawn from terrestrial domains, historical analysis of continental, maritime, and aerial strategies to make sense of what a future space conflict might be defined by. As the Space Age is intricately woven into the Nuclear Age as a race between two superpower nations of oppositional ideologies locked in existential survival, the entire Cold War represents the birth of the space domain as one of human innovation and curiosity paired with politically, culturally, and ideologically violent struggle.

These strange bedfellows of space and nuclear are understandable in that the nuclear age coincided (and overlapped extensively with) the space race. While the Outer Space Treaty of 1967 forbade nuclear weapons in orbit, the technological question of whether a nation might violate this is further exacerbated by whether others can detect such a violation, and if confirmed, enforce some sort of response that punishes the violator. Indeed, the space domain and space security affairs extend a glaring American strategic paradox of the Cold War into how US Space Command and the US Space Force might ever accomplish space superiority or space dominance against near-peer space competitors such as China. If one has not yet weaponized space, gaining space dominance is impossible; rational actor theory also imposes a "zero-sum game" of sorts with national expectations that weaponization in

space will occur regardless. The only secure strategy is that of some expectation that advantages not taken may be taken by a competitor. Yet nuclear arms races are not entirely exchangeable with that of space, and again the space domain requires unique consideration.

American Joint doctrine defines space superiority as "the degree of control in space of one force over any others that permits the conduct of its operations at a given time and place without prohibitive interference from terrestrial or space-based threats."[113] Space dominance, while not in any formal doctrine, suggests that a nation's military would have a commanding influence upon the space domain and by extension from space to terrestrial and cyberspace contexts for defense and security. Domination may be limited in time and space, but it involves operational control and superior tactical and technical abilities over a rival in the same context and time. Thus, space dominance and space superiority require a robust space military capability that exceeds rival ones.

The 2022 National Defense Strategy reinforces this with 45 mentions of "space" and prioritizing building resistance in the space domain.[114] Perhaps the biggest paradox for space defense and deterrence is the rationalized compulsion to develop superior weaponry and countermeasures to conceivably achieve space superiority and, if deterrence fails, operational dominance in warfare. While nuclear space weapons are prohibited by the Outer Space Treaty, it is difficult to determine the enforceability of a document signed by only the United States, United Kingdom, the former Soviet Union and later signed by a handful of other nations. If a nation was to place nuclear weaponry in space, or develop new weaponry that generates similar devastating effects, would this cause further escalation and a new space race of increasingly destructive systems? Autonomous weapon systems are a unique area of concern here, in that a space-based AI weapon system with highly destructive abilities may be unethical or immoral for the United States, but that may not deter a rival from gaining that advantage.

This presents a second serious paradox of the space domain that extends from the earlier and still existing nuclear one. Eccles, a Naval War College professor in the 1960s, in pursuing a unified war theory across all domains and contexts, quoted British writer John Eppstein on how American policies for nuclear weapons are contradictory, even illogical.[115] During the Cold War, American leadership sought to oppose and resist the spread of communist ideology and communist governments worldwide, even engaging in a series of limited and protracted wars such as Vietnam, failed insurgencies in Cuba, across South America, and humanitarian missions such as the Berlin Airlift.

Communism demonstrated incompatible values, and communist regimes could not be trusted in that their core belief systems were incommensurate with

American values of liberalism, capitalism, and democracy. Yet simultaneously, nuclear disarmament negotiations required both sides to assume good faith, trust, and some shared values where an agreement could be carried through and actual nuclear disarmament might occur. Today, this clash of differing ideologies, cultures, and related military escalation of advanced weaponry extends into the space domain. Much of modern foreign policy and military strategy rests upon some form of game theory and the stipulation that both participants in whatever strategic context are rational actors. Yet "rational" does not necessarily correlate to a shared social paradigm or worldview on what war is, or why warfare is required. In this philosophical and ideological perspective, different societies rationalize conflict in different, often incommensurate ways.

China is a communist regime with an entirely different perspective on reality that is adversarial with American views at foundational and philosophical levels. This does not mean that Chinese and American governments cannot maintain some order and stability short of armed conflict, but that ultimately, Chinese communism is another version (or evolution) of the earlier and incommensurate Soviet communism that defined the Cold War. Unlike the Cold War, today's expanding space domain has far more at stake for all spacefaring nations. The expected colonization and economic development of the entire inner solar system represents trillions upon trillions of dollars, radically expanded living space for humanity, and a near infinite supply of energy awaiting exploitation.[116] Such tremendous growth potential requires security, diplomacy, and behavioral norms that are ill-defined or nonexistent today.

The prospect of some Chinese and American military space race may mirror that of the earlier Soviet-American nuclear arms race, with similar paradoxes in differing morals, values, and ideologies. Space weaponry disarmament thus will parallel that of nuclear stockpiles and technology, with neither side willing to trust the other even as the expansion of space weaponry threatens humanity on a new, multi-planetary scale. As competitive or adversarial societies expand into the inner solar system in the decades to come, so too will ever-increasingly complex space security paradoxes. Our next generations of space policy makers, strategists, and military professionals must gain a multi-paradigmatic manner of thinking systemically about warfare that currently does not exist in contemporary war theory, doctrine, or education.

Space is another important frontier for the human species, arguably as significant as when people first became able to travel the seas and reach previously undiscovered lands. In popular culture and television shows such as *Star Trek,* Captain James T. Kirk stated that space is "the final frontier." It may be that, but it is also an *infinite* frontier . . . one that humanity may never be able to explore fully or even comprehend. Terrestrial domains served as the primary planes for organized violence in

most of human recorded history prior to the twentieth century where societies could expand war into new domains such as cyberspace and space.

From here onward, we may continue to engage in complex warfare on the planet, in cyberspace, and into space. Or we may gain new understanding to halt or severely restrict warfare. This is optimistic, but given the historical patterns, unlikely. Security requirements and international conflict likely will extend and expand on an ever-increasing celestial scale that will in time dwarf the terrestrial physical domains of the home planet. Other off-world domains such as continental Mars, continental moons, Martian airspace, and similar asteroid or planetoid variations will emerge through human occupation or exploitation. All these will come with significant security demands and specifications, and they all will be connected and impacted by the overarching space domain.

There is no way to predict or impose control variables to offer any clear pathway into the future in complex, dynamic systems. War is violent, destructive, and while many of the tangible and quantified effects occur in physical reality where natural science laws and principles govern their behavior, war is ultimately a social construction of humanity alone. War is what we make it to be, and the future existence of war is dependent on at least some humans carrying on the requirement for it to remain real. Idealistic visions aside, it is unlikely that war will fade away from societies anytime soon, and it is just as unlikely that future generations might encounter less violent and complex warfare than the current one. Now that humans have produced a virtual world to extend our existence into, cyberspace is a new and expansive area for manifestations of war previously unimagined. This is extending slowly into space, which is a young, immature, but infinite plane of human existence and exploration.

Space is the infinite frontier and carries the paradoxical tension that successful human development beyond this planet will increase the long-term survival potential of the species. Access into just the inner solar system should unlock near unlimited potential in energy, living space, resources, wealth, and prosperity. Such expansion, exploration, and development come with the specter of human war on a celestial scale. There are powerful questions ahead on what a multi-planetary species is, and how it exercises the same different ideologies, cultures, tensions, and developments that historically produced cooperation as well as devastating war on Earth. Celestial security affairs will not just be bigger in scale and scope to past terrestrial ones. The space domain itself transforms war into something that requires new thinking, new definitions, vigorous debate, and critical reflection into what concepts might have been valuable before but are now obsolete and in need of innovative renewal.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 481. There are numerous theories and arguments addressing whether war might be eliminated from human civilization. Of these, Rapoport dedicates several chapters and is a primary source to explore further.

2. The inevitability of war does not correlate to war theorists lusting over future war any more than dentists that study and advance their field because of their love for cavities and tooth decay. War, like many human constructs, accompanies humanity in some form and function through time. Theorists seeking to better understand war do so to develop robust options, including unimagined alternatives.

3. Cyberspace is acknowledged here as a similar emergent and novel domain for future warfare. Cyberspace warrants similar academic inquiry and reflection, but the focus of this paper is emergent space warfare within the space domain.

4. Wildavsky, "If Planning Is Everything, Maybe It Is Nothing," 130; Tsoukas, *Complex Knowledge: Studies in Organizational Epistemology*, 22–23; Weick, "The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster," 628–52.

5. Steam ships and trains forced the development of time zones, and their rapid movement of personnel and resources in the nineteenth century revolutionized war in disruptive, dynamic fashion.

6. Sandberg and Tsoukas, "Grasping the Logic of Practice: Theorizing Through Practical Rationality," 340.

7. Tsoukas, *Complex Knowledge*, 213–16; Daston, *Rules: A Short History of What We Live By*, 233–34; Paparone, *The Sociology of Military Science: Prospects for Postinstitutional Military Design*, 20.

8. Eccles, *Military Concepts and Philosophy*, 114–15.

9. Wylie, *Military Strategy: A General Theory of Power Control*; Builder, *The Masks of War: American Military Styles in Strategy and Analysis*. Carl Builder's book also attempted to explain these primary services from a cultural, historical, and sociological perspective and did not attempt to unify a general theory of war as Wylie did. Wylie and Builder coincidently published in the same year.

10. Wylie, *Military Strategy: A General Theory of Power Control*, 32–55.

11. Hazlett, McAdam, and Gallagher, "Theory Building in Knowledge Management: In Search of Paradigms," 32. Epistemology is how we define the origin of knowledge within our discipline, field or community of practice. It addresses how we know how knowledge functions as well as the limits of what we believe it to be.

12. Wylie, *Military Strategy: A General Theory of Power Control*, 23.

13. Eccles, *Military Concepts and Philosophy*, 50–55; Meiser, "Ends + Ways + Means = (Bad) Strategy," 81–91; Naveh, Schneider, and Challans, *The Structure of Operational Revolution: A Prolegomena*, 35–36; Paparone, *The Sociology of Military Science: Prospects for Postinstitutional Military Design*, 14–22; Zweibelson, "One Piece

at a Time: Why Linear Planning and Institutionalisms Promote Military Campaign Failures," 360–75.

14. Builder, *The Masks of War: American Military Styles in Strategy and Analysis*, 86–92; Kelly and Brennan, "Alien: How Operational Art Devoured Strategy," 8–11.

15. Mahan, *Mahan on Naval Warfare: Selections from the Writings of Rear Admiral Alfred T. Mahan*, 85. A naval entity can occupy a harbor or key water location with respect to land, but historically these attempts to blockade or maintain water positions come with giving up many advantages of sea-going vessels. Fixed naval vessels historically also run greater risk of ground or other targeted attack, restoring the cumulative war strategies associated with water and later air domains. Mahan posits that if selecting between destroying enemy fortified ports and eliminating the fleet, it is the latter that is "the true objective" in maritime strategy.

16. Wylie, *Military Strategy: A General Theory of Power Control*, 23. Wylie, writing the postscript to the book 20 years later, acknowledges that computerization likely increases some forecasting in sea and air domains, but nonetheless those domains' destruction of enemy systems equates with some cumulation of greater control.

17. Corbett, *Principles of Maritime Strategy*, 87–92.

18. Corbett, 90–91.

19. Sun Tzu, *The Art of War: Complete Text of Sun Tzu's Classics*.

20. Corbett, *Principles of Maritime Strategy*, 88–89.

21. Mahan, *Mahan on Naval Warfare: Selections from the Writings of Rear Admiral Alfred T. Mahan*, 49–78.

22. Corbett, *Principles of Maritime Strategy*, 90–91.

23. Mahan, *Mahan on Naval Warfare: Selections from the Writings of Rear Admiral Alfred T. Mahan*, 80.

24. Douhet, *The Command of The Air*, 97.

25. Douhet, 97.

26. Douhet, *The Command of The Air*.

27. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 249.

28. Goswami and Garretson, *Scramble for the Skies: The Great Power Competition To Control The Resources Of Outer Space*, 21.

29. Wylie, *Military Strategy: A General Theory of Power Control*, 41. Wylie's book published in 1967, but in his preface, he explains how it was originally written while he was commanding a ship in the mid-1950s.

30. Shevin-Coetzee, and Hendrix, "From Blue to Black: Applying the Concepts of Sea Power to the Ocean of Space."

31. The First Gulf War demonstrates the first significant use of the space domain in war, but this was an example of technological overmatch between a space superpower (the United States and allies) and a nation without any space capabilities (Iraq). No conflict yet has featured two space-capable nations using the space domain offensively or in any significance that demonstrates the central role of emerging space power.

32. Shevin-Coetzee and Hendrix, "From Blue to Black: Applying the Concepts of Sea Power to the Ocean of Space," 7.

33. Shaw, Purgason, and Soileau, "Sailing the New Wine-Dark Sea: Space as a Military Area of Responsibility," 35. Again, a terrestrial, physical domain may have combinations of both strategies, but the dominant strategy often remains prominent and fixed to that physical domain's primary characteristics. Air forces might show some sequential strategy, but ultimately orient toward cumulative air power strategic theories. Space is "supra-global" if associated with global, terrestrial domains in that it envelops the planet and is the medium that all other celestial objects exist within.

34. Shaw, Purgason, and Soileau, "Sailing the New Wine-Dark Sea: Space as a Military Area of Responsibility," 39–40.

35. Objects enter and exit orbit, and some have maneuver abilities. The distinction here is whether humans control such things, or if the space domain dictates otherwise. This does not occur in air or sea domains. Gravity pulls incapacitated planes to the ground whether the pilot agrees or not. A damaged satellite maintains the original orbit as do debris fields, continuing along unchanged yet no longer controlled by the human designers. Some debris may burn up upon reentry into the atmosphere, others might linger for centuries in uncontrolled orbits threatening any spacecraft in proximity.

36. Spacecraft able to offensively strike and then expend fuel to maneuver out of the debris path of their action might apply here. However, these craft would still endanger anything else in that orbit, including commercial and other nations' spacecraft committed to that particular orbit.

37. Shevin-Coetzee and Hendrix, "From Blue to Black: Applying the Concepts of Sea Power to the Ocean of Space"; Scientific and Technical Information Office, *Space Settlements: A Design Study*, 15–16.

38. Fromm, "Types and Forms of Emergence," 1–23. A positive feedback loop exponentially spirals out of control, removing any system balance as each iteration creates further instability. This is in opposition to "negative feedback loops" that provide system balance and stability.

39. Johnson-Freese, *Space Warfare in the 21st Century: Arming the Heavens*, 18.

40. Douhet, *The Command of The Air*, 24.

41. Douhet, 28–29.

42. Der Derian, "Virtuous War/Virtual Theory," 786.

43. Tsoukas, *Complex Knowledge*, 220; Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity, A Platform for Designing Business Architecture*, 10; Sandberg and Tsoukas, "Grasping the Logic of Practice: Theorizing Through Practical Rationality," 340; Gibson, *The Perfect War: Technowar in Vietnam*, 15–16.

44. Shy, "Jomini," 146; Shy cites the original French text of Jomini.

45. Paret, "Clausewitz," 207; Clausewitz, *On War*, 96.

46. Rothenberg, "Moltke, Schlieffen, and the Doctrine of Strategic Envelopment," 296.

47. Paparone, "How We Fight: A Critical Exploration of US Military Doctrine," 516–33; Nordin and Oberg, "Targeting the Ontology of War: From Clausewitz to Baudrillard," 392–410; Zweibelson, "Gravity-Free Decision-Making: Avoiding Clausewitz's Strategic Pull," 60.

48. Clausewitz and his primary mentor, Scharnhorst, would largely disagree with Jomini's mechanistic principles, but all would seek to use mathematical thinking as part of their overall rationalization of modern warfare. Scharnhorst inspired Clausewitz on subjective constructs such as "passion of the people" and political oversight of warfare to introduce new interpretations of how and why Napoleon changed European warfare. Paret, *Clausewitz and the State: The Man, His Theories, and His Times*, 375–81; van Creveld, *The Training of Officers: From Professionalism to Irrelevance*, 99; White, *Scharnhorst: The Formative Years, 1755–1801*, 332.

49. Durand and Vergne, "No Territory, No Profit: The Pirate Organization and Capitalism in the Making," 264–72.

50. The focus of this paper is on the space domain, but this topic offers multiple parallel considerations for cyberspace as a unique domain. Further research for cyber applications is needed.

51. If the population resides largely in a single terrestrial location, more of the Clausewitzian theory on "will of people" may apply. If the population is dispersed across celestial locations or colonies, or if the space domain creates new inabilities for an occupying force to influence the will of the people, less of the Clausewitzian theory may remain valid.

52. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 469.

53. If nations with weaponized space systems or the ability to target spacecraft are deterred from doing so in a future conflict, the space domain may only exercise nonviolent civilian and commercial defense for either side, excluding space systems under total control of any warring nation.

54. Certain space infrastructure may be too difficult to transfer or relocate due to geographic, infrastructure, power, or technological reasons. These ground-based nodes would become "high value targets" in any military offensive operation to preclude such risks of civilian defense.

55. Goswami and Garretson, *Scramble for the Skies: The Great Power Competition To Control The Resources Of Outer Space*, 87–88.

56. Scientific and Technical Information Office, *Space Settlements: A Design Study*,16–17.

57. Unlike the East India Companies that had numerous requirements and obligations to their home nation, an international or independent space enterprise (whether scientific or industrial) could choose in formation of their charter documents and enterprise ethos a "non-hostile ordering" that could influence other ventures and stakeholders. A different "Kessler cascade" not involving debris could occur at a societal and international economic level, producing vastly more spacecraft operating in a civilian defense that resists or rejects existing Westphalian nation state military interests for a greater good for a space-faring species.

58. Douhet, *The Command of The Air*, 96. Douhet was an early proponent of this in 1924 where "adequate air forces can crush the material and morale resistance of the enemy."

59. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 115–51; Eccles, *Military Concepts and Philosophy*, 53–60; Malešević, *The Sociology of War and Violence*, 22–26.

60. Woermann and Cilliers, "The Ethics of Complexity and the Complexity of Ethics," 447–63; Herzfeld, "Can Lethal Autonomous Weapons Be Just?" 70–86; Scharre, *Autonomous Weapons and the Future of War: Army of None*.

61. Scientific and Technical Information Office, *Space Settlements: A Design Study*, 25–36.

62. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 298–303.

63. Many advocates of space colonization insist that humans must become an inter-planetary species to ensure survival, gain necessary energy, resources, and living spaces beyond Earth. This is arguably a likely future pathway for the species, but in the next several decades, AI systems will be the safer, cheaper, and reliable option *for the initial phases* of eventual human colonization.

64. Paret, "Clausewitz," 206.

65. This is based on current human and technological limitations. It is feasible that in the coming decades, a human could operate in space and engage in warfare within the space domain for long periods, but this remains cost prohibitive except for select advanced nations such as the United States.

66. Goswami and Garretson, *Scramble for the Skies: The Great Power Competition To Control The Resources Of Outer Space*, 1–22.

67. Herzfeld, "Can Lethal Autonomous Weapons Be Just?" 74–76.

68. General AI is still decades away according to leading AI theorists, but once developed, such AI would equal or out-perform a human in every possible cognitive function. Hypothetically, general AI would be most appropriate in the space domain, in that human operators would remain too fragile and costly.

69. Sadler and Regan, "DeepMind's Superhuman AI Is Rewriting How We Play Chess."

70. Herzfeld, "Can Lethal Autonomous Weapons Be Just?" 80–82; Molloy, "Project Governance for Defense Applications of Artificial Intelligence: An Ethics-Based Approach," 111.

71. Gravity is one area of clear interest. Humans modified with denser or lighter skeletons, different chemical or organ capabilities may make them suitable for various off-world conditions. This raises profound ethical, moral, and legal concerns. Future colonies on other planets or celestial locations may be unable to visit Earth with ease due to these modifications as well.

72. Bostrom, *Superintelligence: Paths, Dangers, Strategies*, 26.

73. Bostrom, "What Is a Singleton?"

74. Shatzer, "Fake and Future 'Humans': Artificial Intelligence, Transhumanism, and the Question of the Person," 133–34.

75. Pugh, Soros, and Stanley, "Quality Diversity: A New Frontier for Evolutionary Computation," 5.

76. Anslow, "In 1903, New York Times Predicted That Airplanes Would Take 10 Million Years to Develop."

77. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 347.

78. Rapoport, 347.

79. Bruner, "The Narrative Construction of Reality," 1–21; Hatch and Yanow, "Methodology by Metaphor: Ways of Seeing in Painting and Research," 23–44; Schön, "Generative Metaphor: A Perspective on Problem-Setting in Social Policy," 137–63; Putnam, "The Interpretive Perspective: An Alternative to Functionalism," 31–54; Weick, "Organizational Communication: Towards a Research Agenda."

80. Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity, A Platform for Designing Business Architecture*, 60.

81. Wylie, *Military Strategy: A General Theory of Power Control*.

82. Wylie, 41.

83. If one measured different speeds for cyberspace, the results of how information moved from sender to various destinations would not correlate to physical reality aside from arrival at the hardware connected to a physical domain. Further, there is no physical distance between one application or another and how users digitally engage. Cyberspace involves information and time, with all conceptualizations of physical space dependent upon physical domains that support the existence of cyberspace.

84. US Army Training and Doctrine Command, *The U.S. Army Functional Concept for Movement and Maneuver: 2020–2040*, 15.

85. Herzfeld, "Can Lethal Autonomous Weapons Be Just?" 85.

86. Currier, "Leaked Files: German Spy Company Helped Bahrain Hack Arab Spring Protesters."

87. Moltz, *Crowded Orbits: Conflict and Cooperation in Space*, 28–29.

88. Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity, A Platform for Designing Business Architecture*, 51.

89. Rapoport, *The Origins of Violence: Approaches to the Study of Conflict*, 258.

90. Moltz, *Crowded Orbits: Conflict and Cooperation in Space*, 126; Wright, Grego, and Gronlund, *The Physics of Space Security: A Reference Manual*, 8–11.

91. Johnson-Freese, *Space Warfare in the 21st Century: Arming the Heavens*, 26.

92. Johnson-Freese, 26–49.

93. For example, the television show *Star Trek: Deep Space Nine* centers on a space station orbiting a planet in an unimportant area of the galaxy when a stable worm hole is discovered nearby. Suddenly, the remote outpost has tremendous strategic value, and becomes a new area of tension and conflict for competing actors.

94. Eccles, *Military Concepts and Philosophy*, 115. Eccles cites: James King Jr, "Nuclear Plenty and Limited War", *Foreign Affairs,* Vol. 35, No. 2 (January, 1957), 256.

95. Schultz and Hatch, "Living with Multiple Paradigms: The Case of Paradigm Interplay in Organizational Culture Studies," 529–57.

96. Vagts, *A History of Militarism: Civilian and Military (Revised Edition)*, 12–13.

97. Solar System Exploration, "What Time Is It in Space?"

98. Lindsay, "TWE Remembers: Secret Soviet Tactical Nuclear Weapons in Cuba (Cuban Missile Crisis, a Coda)."

99. Zeitchik, "The Future of Warfare Could Be a Lot More Grisly than Ukraine."

100. This occurs beyond the initial mission or operational instructions. For narrow AI, prediction of behavior may remain consistent and acceptable to human programmers and designers. With general AI systems, this is increasingly unrealistic.

101. Moltz, *Crowded Orbits: Conflict and Cooperation in Space*, 37.

102. Joint Chiefs of Staff, *Joint Operations*, II-2.

103. Glenn, "Mission Command in the Australian Army: A Contrast in Denial," 21.

104. While nuclear weapons may not be the only concern in space conflicts, the potential of nuclear or other high-energy power systems for spacecraft and space stations will pose similar risks. With technological developments, weapons and effects that exceed even nuclear destruction likely will emerge, and be considered for celestial security requirements by multiple competitors.

105. King, "Mission Command 2.0: From an Individualist to a Collectivist Model," 12. Just as with attempts to disarm and eliminate nuclear weapons, it is possible but unlikely that all nations and key actors would agree on banning highly destructive weapons or systems from any possible space conflict.

106. Moilanen, "The Wisdom of Tacit Knowing-in-Action and Mission Command," 106.

107. Moltz, *Crowded Orbits: Conflict and Cooperation in Space*, 62; Yeomans, "Beware of Errant Asteroids," 12.

108. Again, Clausewitzian war theory seeks the destruction of an enemy military force through offensive action to break the will of the people. It orients on human versus human conflict, with the requirement for the winning side to have dominance over the loser. In nuclear mutually assured destruction, this construct collapses. In existential celestial phenomenon, any space faring nation or actor able to protect humanity is compelled to act in a species-wide act, even if one is currently engaged in a conflict. With smaller space objects that might land on one's enemy population during a conflict, the ethical and moral concerns remain but could be challenged by devoted modern war proponents.

109. Marshall, "Some Thoughts on Military Revolutions," 1.

110. Marshall, 3.

111. Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity, A Platform for Designing Business Architecture*, 26, 112.

112. Tsoukas, *Complex Knowledge*, 242; Schön, "Generative Metaphor: A Perspective on Problem-Setting in Social Policy," 143.

113. Joint Chiefs of Staff, *Space Operations*.

114. Department of Defense, *2022 National Defense Strategy*, 16.

115. Eccles, *Military Concepts and Philosophy*, 40.

116. Goswami and Garretson, *Scramble for the Skies: The Great Power Competition To Control The Resources Of Outer Space*, 1–22.

Abbreviations

AI	Artificial Intelligence
EMP	Electromagnetic Pulse
GMT	Greenwich Mean Time
LEO	Low Earth Orbit

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