



The Operational Environment, 2035-2050: The Emerging Character of Warfare

(Inside Cover)

This study was developed by U.S. Army Training and Doctrine Command (TRADOC) to synthesize and summarize the best available evidence to discern the future character of conflict, with a particular focus on the land domain. Although what follows is foresight, rather than history, it is based on a body of accumulated research by the United States Army and its partners in the Joint, Service, and multinational communities.

This edition of the Operational Environment (OE) builds on the 2012 edition of the Army Operational Environments to 2028, as well as ongoing TRADOC research, including the Mad Scientist series of events, the Unified Quest wargames, and OE work undertaken by the CSA Strategic Studies Group. Moreover, it has incorporated new research on national strategic futures and future joint warfighting as found in a range of studies and reports, but primarily the National Intelligence Council's Global Trends and the Joint Staff's "Joint Operating Environment 2035."

Unlike the 2012 OE document, this edition will eschew the Operational Environment Assessment (OEA) Framework of Analysis and its application to global regions in order to focus on the emerging character of warfare between competing great powers. The OEA frameworks will be updated in a separate document.

Great powers in this document are "peer" or "near-peer" competitors who -- because of either global reach or geostrategic advantages within their region -- are able to contend with others on a generally equal footing. Although their aggregate levels of power are equivalent, their capabilities are not necessarily symmetric: they are not mirror images of each other.

Executive Summary

As human nature endures, so too will the nature of war. It will immutably remain a political act extended to the realm of violence, with inevitable chance, fog and friction. War is indelibly etched into our nearly six thousand year written record of humanity, and will be with us in 2050 as well.

Despite war's enduring nature, the character of warfare is changing: significantly, rapidly, and irreversibly. Transformative technologies, including artificial intelligence, robotics, biological and genetic engineering, human machine interfaces, global social media, space access, and much, much more suggest a future operational environment far different than today.

Because warfare is a human phenomenon, we must first understand how humans will live, create, think and prosper. In fact, the character of warfare is shaped and defined by the intersection of these varying trends – the “spirit of the age” as Clausewitz called it. Consequential technological, social, and global changes over the next three decades will challenge land forces everywhere to evolve and adapt.

Section II of this Operational Environment opens our fictional Observer's “history of the future” by depicting how the strategic security environment has evolved over time. In this world, the

familiar “Post-Cold War Order” is history. In its place, a more competitive “Prelude Period” (2017 to 2035) has emerged, featuring states and global ideological networks accelerating investments in weapons, technologies and novel operational and strategic concepts to prepare for the “future conflicts many perceived as inevitable.” Between 2035 and 2050, our Observer describes an “Era of Contested Equality,” in which the nation-state survives, but is beset by a range of challenges – and challengers. In the Era of Contested Equality, states of global and regional reach, transnational networks,

A NOTE ON “VOICE”: REFLECTION AND PROJECTION

Much of this Operational Environment is written in a style that differs dramatically from other military futures reports. First, it is written by an anonymous “Observer,” a fictional, Thucydides-like character who seeks to describe a world in conflict from an impartial, analytic perspective.

Throughout, the reader should remember that this “Observer” is positioned in 2050 and is looking back over the span of nearly 40 years, attempting to understand, visualize, and describe the conditions, challenges, competitions, and implications bearing on the mid-century character of warfare.

Throughout this document, the reader will find **REFLECTIONS** and **PROJECTIONS**. **REFLECTIONS** are fictional looks back, while **PROJECTIONS** look forward and cite quotations illustrating actual observations from today's world.

We ask the reader to take a leap to 2050 with our Observer, setting aside 2017 and reflecting on the changing character of conflict as it unfolds over time.

terrorists, and even super-empowered individuals have adapted and translated combinations of economic strength, technological prowess, and – in some cases -- uncompromising and violent ideologies into effective strategic strength.

Section III describes how the operational environment trends have shaped the characteristics and challenges of military operations in the 2035-2050 period. Our Observer provides a knotty list of global and theater challenges confronting multiple great powers. Collectively, these challenges pose the problems that must be solved by those who intend that their armies shape the world, provide order, or protect national interests from coercive threats.

The interaction of multiple great powers – similarly equipped with new capabilities and simultaneously trying to address those future operational tasks -- are the dominant driver of a fundamental change in the character of warfare described in **Section IV**. The simultaneous and interactive competitions of *finders vs hiders* and *strikers vs shielders* will generate a battlespace of unprecedented lethality. Combatants will struggle – and aggressively innovate – to generate *survivable close engagement* in the face of formidable adversary *range* and *lethality*. The advantages of *connection*, *aggregation* and *centralization* will trade against equally compelling motivations for *disconnection*, *disaggregation*, and *decentralization* – with the probable result of a widely distributed, non-contiguous battlespace. In such a battlespace, at least between peer competitors in the land domain, the *defense* will be relatively advantaged over the *offense*.

Emerging capabilities in robotics, autonomy and artificial intelligence will present future combat developers with interesting trade-offs between *planning* versus *reaction*, and *judgement* versus *autonomy*. Competitors will have daunting *escalation* capabilities, making escalation advantage a prominent feature of future force design, doctrine and policy. The extended range and precision of land based systems will extend their effects more routinely and more effectively into the other *domains*, so that legacy combined arms synergy now extends across multiple domains. Similarly, there will be widespread recognition that conflict is a competition, not only across every domain in the physical *dimension*, but also across the cognitive and moral *dimensions*.

With these competitions defining the character of conflict, our Observer goes on to remind us in **Section V** that future battlefield success is contingent on current strategic, conceptual and innovation decisions. The drivers of outcome found in this section represent a set of critical institutional factors that should inform how we might adapt and evolve to prepare for the future character of warfare. Returning to the ‘real world’ of 2017, these drivers provide critical implications of the “spirit of the age” and changing the character of conflict for the United States Army, as well as the Joint Force and the Nation.

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I. Introduction

The U.S. Army asserts that the character of conflict is changing: significantly, rapidly, and irreversibly. An evolving strategic environment presents daunting challenges for the U.S. military, and specifically for the land forces of the United States. We already sense ourselves on the cusp of being *out-gunned, out-ranged, out-protected, out-of-position, and out-of-balance*.¹ These challenges pose difficult -- even intractable -- impediments to current U.S. operational approaches and capabilities. They demand comprehensive adaptations to how we fight, and how we prepare to fight.

This Operational Environment (OE) presents the Army's current thinking about the future character of warfare. It imagines the next several decades from the perspective

REFLECTION (411 BC): "Thucydides, an Athenian, wrote the history of the war...
Thucydides: "The History of the Peloponnesian War"

of an anonymous observer looking back in time from a future, mid-century vantage point. The observer summarizes the most significant trends of the strategic security environment, and describes the challenges those trends

posed to military operations, particularly land warfare. He depicts the character of warfare in the period 2035 to 2050 as a series of simultaneous, interactive competitions as combatants apply diverse operational solutions to those challenges. He also assesses the significant drivers that determine the outcome of those competitions.

Our future observer pays scant attention to the specific identity of nation states, groups or individuals. His focus -- and the focus of this Operational Environment -- is an understanding and distillation of the essential character of future warfare. He does not assume imminent strategic, policy, or force development decisions of the United States. He does not predict adversaries, nor the specific dynamics of future conflicts. He describes a range of challenges, choices and consequences confronting competitor great powers in future warfare. The exact role and outcomes for the US and others in that warfare are "to be determined": dependent on the decisions they must soon make to prepare for that future.

PROJECTION (2016): "It is my belief that we are on the cusp of a fundamental change in the character of warfare, and specifically ground warfare ... the failure to connect those dots pre-World War I, the failure to see and the failure to connect those dots in the 1920s and '30s ... cost 100 million lives, a huge amount of blood, and years and years of human suffering. It is our task, the task of you and I, the task of us, both civilian and military, to do better, to see the trends, and to get the future less wrong than our enemies."

GEN Mark Milley

Although our future observer and his predecessor of nearly 2500 years would not recognize the character of each other's war, they would jointly comprehend its nature. As human nature endures, so too will the nature of war. It will immutably remain a political act extended to the realm of violence, with inevitable chance, fog and friction. Future war remains a duel of wills, where "the strong do what they can and the weak suffer what they must."² The intent of this document is to prepare us for that duel by exploring its anticipated context and character.

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II. Strategic Security Environment, 2035-2050

REFLECTION (2050): “Any understanding of conflict and the character of warfare during the great conflicts of this era must first understand the conditions that defined the most important elements of our strategic security environment, and the processes by which these conditions emerged.”

Anon: “*The History of the Era of Contested Equality*”

Mid-Century Conditions

Recent decades have witnessed far-reaching changes in how people *live, create, think*, and *prosper*.³ In retrospect, the inexorable demographic and economic **extended** trends of this century were evident at its start and were not immune to long term forecasting and projection. In other cases, technological and socio-political **disruptive** trends were far less predictable and have generated considerable strategic shock and surprise. Extended and disruptive trends combined and transformed the strategic security environment from the post-Cold War to today’s era of protracted global competition.

Live. Humanity is – in the aggregate -- richer, older, more urban, and better educated than at any time in history. In some cases, the appetite for conflict and war is diminished. In many cases, however, the uneven distribution of this progress has accelerated the motivations for warfare. The convergence of more information and more people -- together with less community cohesion and fewer state resources -- constrains the ability of governance to address rampant poverty, violence and pollution: a breeding ground for discontent among increasingly aware, yet still disempowered, populations.⁴

The addition of over seven billion people over the last century has altered geography itself.⁵ Cities sprawl over large areas of the globe with complex, distributed urban areas containing 66% of the world’s population.^{6 7 8} Some megacities are more important politically and economically than nation-states; some have indeed “out-grown” their host state.⁹ Climate change has opened arctic sea routes and raised sea levels.

The increase in global population has been far from even.¹⁰ Education has progressed everywhere, but regional differences are significant.¹¹ Unequal access to quality education drives uneven economic growth, and differentiates the benefits of participation in global trade. These trends drive unemployment, migration, and the availability (and inclination) of individuals fit for military service.¹²

The National Intelligence Council’s 2017 prediction of a new age of migration and protracted refugee crises proved correct.¹³ Growing and shifting populations increasingly compete for water, food, fossil fuels, and unique mineral resources.¹⁴ Isolated regions see food production significantly lag population growth, but the causes of food scarcity are typically domestic conflict, poor governance, and mismanagement

rather than a lack of arable land.¹⁵ Pollution, contamination, and over-use have rendered water a “non-renewable” resource in many portions of the globe; water scarcity increasingly drives conflict. Driven by climate change, water and food scarcity, uneven economic opportunity, and political and social insecurity, mass migration has presented significant governance challenges to receiving states as these migrants concentrate predominantly in urban areas.¹⁶ Social stresses and fractures between migrants and native societies are not uncommon as robust, alternative means of connectivity delay and frustrate assimilation.

Create. Although more human beings stress available resources, population growth has also compounded the rate of innovation and technology development. Human creativity is now clearly the most transformative force in the world, both enhancing human life, but also upending it and – at times – precipitating catastrophic, disruptive events. Creativity is also the driving force behind new strategic advantages / vulnerabilities for nations, their military forces, and for armies around the world.

Information technology has continued to improve exponentially, vice linearly. Humans interact with digital objects via tactile interfaces and pervasive sensor tracking. Most of the developed world is instrumented in some way. In some urban areas, all physical traffic signals and signs have been eliminated as robotic systems and direct-to-retina displays provide all necessary data through the net. More broadly, nearly every person on Earth uses a connected, mobile device. Often these phones run through satellites or high-altitude balloons and drones that bypass national telecommunications altogether, ensuring open access to the world’s information, but creating tension between states and these commercial providers.

Advanced material capabilities have extended the century’s trend toward reduced size, weight and power (SWAP) requirements, as nanomaterials, metamaterials and bespoke structures allow for multifunctional assemblies, vastly improving overall system integration, reliability, and performance. Advanced materials have significantly improved battery power and performance, allowing large amounts of power to be stored across a distributed grid and miniaturized storage powers mobile robotics and vehicles of all types.

Think. Artificial Intelligence (AI) has proved to be the most disruptive technology of our time: much of today’s “thought” is artificial, vice human. Breakthroughs in AI and deep learning enable reasoning intelligent systems that, though not sentient, administer and optimize a great many aspects of modern life. The vast majority of the cyberspace information flow consists of direct machine-to-machine autonomous communications. Advanced physio-mechanical interfaces enable human-machine integration to include optimized searching of massive indexes of data, direct access to large-scale computing power, and life-like experiences through virtual reality.¹⁷ The revolutionary impact of “trans-humanism” challenges the very definition of “human” – with profound ethical dilemmas that remain, to this day, unresolved.^{18 19}

Big data techniques interrogate massive databases to discover hidden patterns and correlations that form the basis of modern advertising – and are continually leveraged for intelligence and security purposes by nation states and non-state entities alike. Quantum computing, first applied to encryption functions, is now a key computing enabler, especially for AI.²⁰ End-to-end optical computing and communications techniques based on quantum phenomena threaten to obsolesce many current command and control and electronic warfare capabilities.

A mature Internet of Things (IoT) connects and integrates the devices of the information realm with formerly inert objects – structures, motors, or appliances -- of the physical realm. This robust IoT is a large risk surface for adversary surveillance and attack²¹ wherein combinations of autonomous robotics and cyber warfare can transform a productive “Internet of Things” to a destructive “Botnet of Things.”²²

Neuroscience has enhanced our understanding of brain function, including neural plasticity, and has enabled advanced techniques for human-machine interfacing.²³ A better understanding of the machinery of the mind has found commercial application in the acceleration of speed and retention in learning. In the most connected and wealthy parts of the world, cell phones and computers have all but disappeared as physical, hand held devices. Select individuals directly connect to cyberspace through neural implants or augmented reality systems painted directly on a retina. Decision science has deepened our understanding of choice mechanisms for individuals, organizations and societies.²⁴

Prosper. Although AI and its associated technologies have shattered many industries and livelihoods, a wide range of advances continue to create new sources of wealth and economic development – while also significantly impacting the strategic security environment.²⁵ Despite significant ‘deglobalization’ trends, the world economy has more than doubled since 2020.²⁶ Dramatic economic growth in middle-income countries since the early 21st century has rebalanced the global economy significantly, with the “emerged 7” of fast-growing, heavily populated powers nearly doubling G7 economies.²⁷ The distribution of global wealth is slightly more equal but this relative improvement is not distributed evenly across the globe. The bottom 30 per cent have seen almost no improvement in their relative economic position.²⁸ Relative deprivation drives instability; not deprivation per se – and in a world increasingly connected regardless of income level, the deprived are painfully aware of their relative status.^{29 30}

Robotics and autonomous systems underpin the smooth functioning of advanced societies. Mobile robotic systems are ubiquitous, and controls of most transportation assets are “human optional.” In many places on Earth, it is illegal for humans to actually drive on public roads as the risk of human error is far higher than with autonomous vehicles. Additive manufacturing, computer-aided design and millions of industrial robots have dislocated significant portions of the global supply chain. Industrial manufacturing is even more distributed and less centralized than just 20 years ago, featuring small-batch “foundries” producing custom designs – which are then transported and delivered by a range of autonomous air, land, and sea vehicles.

Virtually anyone in the world with access to a computer system and 3D printer can “print” anything from drones to weapons.

Encrypted blockchains have proved to be massively disruptive to commerce functions such as payments, trade finance, and more.³¹ Together with robotics, autonomy and AI they comprise a perfect storm for “blue collars” and “white collars” alike, causing vast economic displacement as formerly high-quality information technology and management jobs follow the previous path of agricultural and manufacturing labor. The broadly reduced demand for labor and narrowing participation in economic activity destabilizes both economies and political norms.^{32 33 34}

The world’s energy system has moved substantially away from fossil fuels. Investments in smart energy grids, battery storage, and hyper-local solar and wind generation now account for over 50 percent of global electricity consumption. Energy demand has continued to rise but energy solutions have kept pace. Technologies ranging from fracking, fuel cells, compact and mobile nuclear fusion, ocean thermal energy conversions, biomass, and wind provide multiple options to supplement legacy power generation technologies and meet the inevitable rising energy demands of a growing world population. These alternative energy technologies have rendered difficult and destabilizing consequences for states reliant on oil and gas production.

Additive manufacturing has enabled high volume production of nano-satellites, ‘democratizing’ space with capabilities available to most nations and many non-nation entities. Over fifty countries have a substantial presence in outer space, with ten nations having economically-viable, independent space launch capabilities.³⁵ Reusable rockets and single-stage to orbit capabilities have encouraged a large and growing satellite industry – particularly in the small-sat / cube-sat market. On-orbit repair and refueling capabilities significantly increase the maneuverability and service life of satellites of all types. Several companies have begun mining asteroids and bringing ores back to Earth, and some are exploring moving refining capacity to space itself to support burgeoning space industries. Spacefaring nations promise to license these activities and protect their own nationally-registered companies.

Biotechnology has finally hit its stride. Much of the chemical and materials industry has been replaced or augmented by a “bio-based economy” in which precision genetic engineering allows for bulk chemical production. Individualized genetics enable precise performance enhancements for cognition, health, longevity, fitness, and cosmetics. The demand for even invasive and far-reaching biological enhancements has created markets and demand that, to date, have outpaced authorities’ attempts at control. Such control is urgent: extremist groups can create a genetically engineered weapon of mass destruction (WMD) with few indications and warnings.^{36 37}

The Post-Cold War Baseline

The trajectory of our recent history must account for its original launch point. It is now clear that the extended and disruptive trends that generated our mid-century conditions were simultaneously eroding the former primacy of superpowers. At the time, the fundamental issues driving this change were so elusive and diffuse³⁸ that the era earned no name in its own right: early century strategists and commentators referred to their time as “the **Post-Cold War** World” -- more notable for what preceded it.

The U.S. had encouraged and nurtured core strategic advantages, most notably, a broad network of alliances and partnerships around the world coupled with a very capable Joint Force. Even when forward presence did not effectively prevent aggression, the U.S. Joint Force could exercise ‘deterrence by reversal,’ projecting follow-on forces through the global commons with the capacity to reverse aggression through the decisive application of landpower. Together, these advantages had, for decades, allowed the U.S. to assure its allies and protect interests around the world.

By 2017, the erosion of these strategic advantages was both real and apparent. Increasingly aggressive challengers developed and fielded a full range of modern, advanced military capabilities. Investments in electronic warfare and space control threatened U.S. command and control, while forward bases, naval vessels, and aircraft were menaced by integrated air defenses and long range cruise and ballistic missile systems. The ability of the Joint Force to operate effectively in the air and maritime domains hundreds of miles from adversary coasts eroded, and large land formations were increasingly ranged by accurate, volume fires.³⁹ The post-Cold War “Unipolar Moment” had faded.⁴⁰

The Prelude Period, 2017-2035

In retrospect, as world leaders witnessed the tectonic forces at work during the Post-Cold War, particularly the redistribution of global economic power, how could they have not anticipated a concomitant redistribution of strategic power? The role of leading economic power changed hands multiple times⁴¹ and powerful competitors challenged the post-Cold War Era’s liberal world order. Some challenges were economic in origin; others sought a return to primacy or hegemony in their region. Some feared that their authoritarian regimes or traditional cultures would not survive open and free interaction with that liberal world order. Regardless of motivation, the **Prelude Period** between 2017 and 2035 was a mobilization for future contests many perceived as inevitable.

During the Prelude Period, strategic competitors accelerated investments in both weapons and novel operational concepts to employ them. Deeply violent, ideologically motivated transnational terrorists, insurgents, and super-empowered individuals took advantage of a sea of proliferating weapons, off the shelf commercial technologies, and even more advanced computer-aided design and manufacturing capabilities. Adapting adversaries put themselves on a military innovation trajectory that by 2035 would

increase their capacity to reshape, shrink and perhaps unravel altogether the authority, extent, and legitimacy of the early century liberal world order.

The Era of Contested Equality, 2035 – 2050

Today, at mid-century, great powers and rising challengers alike have converted hybrid combinations of economic power, technological prowess and virulent, cyber-enabled ideologies into effective strategic strength. They apply this strength to disrupt or defend the economic, financial, social, and cultural foundations of the old liberal order. They assert or dispute regional alternatives to established global norms. State and non-state actors compete for power and control, often below the level of traditional armed conflict – or shield and protect their activities with escalatory nuclear options and doctrines. Strife, conflict, and war remain endemic in mid-century and the ways in which wars are fought have undergone a significant evolution – nowhere more so than in the land domain. The ***Era of Contested Equality*** is upon us.

The Nation State Perseveres. The nation-state, while remaining the major actor in the international system, is weaker than at the start of this century, both domestically and globally.⁴² Enhanced global governance has not offset nation-state deterioration: recent decades, in fact, have demonstrated trends of fragmentation, competition, and limited multipolar power arrangements that have frustrated international cooperation.⁴³ “Peak Globalization” is far behind us at mid-century, with both collective security and globalism in decline.⁴⁴ The nation state, moreover, does not lack competitors. Many face challenges from insurgents and global identity networks which either resist state authority – sometimes violently – or ignore them altogether.

States share their strategic environment with networked societies which increasingly circumvent governments unresponsive to their citizens. Many groups experiment with collective intelligence gathering, online social collaboration, and tracking of social capital through online trust and voting systems. States and individuals track and quantify social activity – both online and in the real world – to assess trust. Some states ‘grade’ the allegiance and patriotism of their citizens and keep (and even publish) individual social trust scores to control citizen behavior.

Super-Power Diminishes. Early century great powers have lost their dominance in command and control (C2), surveillance, and precision-strike technologies as even non-state actors acquire and refine their own application of these technologies in conflict and war.^{45 46} Rising competitors, moreover, leverage a “second-mover advantage” that lets the former leaders assume the sunk costs of expensive new technologies while knowledge diffusion, cyber intellectual property theft, and their own advanced economies quickly adapt or counter new “offsets.”⁴⁷

Among nation-states, the “high table” of great power *peer competitors* is larger and somewhat higher, but the ‘middle powers’ have been in decline. This gap between “high table” and “low table” has altered the Strategic Security Environment.⁴⁸ Low

table competitors frequently alter their partnerships with the great powers, upsetting regional and global balances. 'Communities of Interest' frequently transcend geopolitical boundaries, destabilizing borders and eroding homogenization within nation-states.⁴⁹ "Conflict entrepreneurs" use ideological and religious narratives to mobilize disaffected populations more susceptible to violence because of climate change, migration, food insecurity, water shortages, and economic crises.⁵⁰

The costs of maintaining global hegemony in this century is not within the reach of any single great power. This balance of power world is also a multi-polar one that features privileged spheres of influence in the regions of many states, persistent tension, and inherently instability. Balance "restoration" is fraught with peril in the face of competent and motivated peer competitors.

Interests Collide. Great powers – legacy, revanchist or rising -- continue to pursue their own interests. The ensuing collision of interests range from *collaboration* to *conflict* as adversaries seek spheres of influence that afford explicit or tacit primacy in their immediate periphery and beyond. Increased chaos and conflict force competitors to make careful choices to achieve foreign policy goals consistent with priority national interests. Interests collide over many things, including the control of resources to power growing economies, protection of fresh water sources, the preservation of ideological / political integrity from foreign influence, or simply the desire for geographic space or terrain.

The collision of interests extends beyond nation-states. A global, super-connected social media polarizes -- vice homogenizes -- public opinion. "Interest group" boundaries rarely match nation-state borders. Thucydides' enduring motives -- *fear*, *honor*, and *interest*⁶¹ -- are now unchained from state control. The rhetoric of nationalism, cultural and social identities, and even cosmopolitan or transnational ideologies propel rivalries between and among states, non-state actors and super-empowered individuals. Extreme religious, nationalistic, or cause-focused groups are the engine of "identity-based turbulence."

The Struggle: Contested Norms, Persistent Disorder. In the Post-Cold War Era some encouraged a universal view which argued for self-determination and free association of states – even if located near another great power. Today, in this Era of Conflict, multiple state and non-state actors assert alternative rules and norms; although many claim universality, these alternative "norms" are often irreconcilable.

Very advanced military capabilities and "whole-of-government" levers can apply information warfare, cyber-attacks, and outright coercive military action to corrode and

PROJECTION (2016): "The future security environment will be defined by twin overarching challenges ... Contested norms will feature adversaries that credibly challenge the rules and agreements that define the international order. Persistent disorder will involve certain adversaries exploiting the inability of societies to provide functioning, stable, and legitimate governance. Confrontations involving contested norms and persistent disorder are likely to be violent, but also include a degree of competition with a military dimension short of traditional armed conflict."

Joint Staff J7: Joint Operating Environment 2035

destroy the foundations of state power. Certain revisionist states often view the fracturing of weaker states as an expedient way to change various regional balances of power in a manner favorable to their interests, and both state and non-state ideological networks constantly conduct integrated political and military actions to undermine the military, economic, psychological, or political strength of competitors.⁵²

III. Challenges of Military Operations, 2035-2050

REFLECTION, 2050: “The relentless change that swept through every aspect of the Prelude Period and into the Era of Contest did not spare the realm of conflict. Our mid-century strategic security environment significantly altered *“the factors and circumstances that bear on military operations:” the Operational Environment (OE)*. The characteristics of this OE posed operational challenges -- manifest at both a global and regional theater level – distinct to our time.”

Anon: “The History of the Era of Contest”

Characteristics of the Operational Environment

The Era of Contested Equality OE presents a series of unique characteristics that drive competitive adaptations.

Contested in all Domains. Competitors contest all domains, neither accepting nor assuming sanctuary in any part of the land, air, sea, space, and cyberspace. Complex and lethal engagements permeate the battlespace from the deep seabed to geosynchronous orbit. Land, sea, air and space platforms encounter long range precision munitions, highly accurate guided missiles, lasers and microwave weaponry, stealthy and agile swarming

Operational Environment Characteristics

- Contested in All Domains
- Unprecedented Speed; Elusive Resolution
- WMD Proliferation
- Complex Terrain the Norm
- Hybrid Combatants

PROJECTION, 2016: “Most conflicts will quickly become transregional -- expanding beyond one or two countries -- and become multi-domain, to include land, sea, air, space, and cyberspace. ... We need to make sure in the context of transregional, multidomain, multifunctional conflicts that we have the right command-and-control construct in place to integrate joint capabilities and support rapid decision-making by national command authorities.”

General Joseph Dunford

robotic systems, and continuous probing of cyber systems. This contest extends to both control and use of the entire electromagnetic spectrum. Domain competition includes ongoing measures to degrade the effectiveness of AI, battle management, and firmware targeted even down to chipset level in any platform or weapon. This lethal exchange is not only characteristic within each domain, but

also between them: the range and precision of sensors and weapons allows routine cross-domain engagement. Forces without countermeasures and defenses integrated across all domains are quickly degraded.

Unprecedented Speed; Elusive Resolution. In our highly-connected mid-century world the momentum of human interaction unfolds at unprecedented speed. The speed of many Era of Contested Equality engagements – laser systems, hypersonic weapons, cyber-attacks -- far exceeds the reaction ability of normal humans. Significant battle processes are highly automated and supervised by cognitively augmented humans and man-machine “centaur” teams. Modern manufacturing accelerates the rate of capability

development so that by 2050, forces must have a very dynamic capacity to adapt and integrate capabilities, both materially and cognitively.

Perversely, however, the speed of battle does not accelerate its decisiveness. Because competitors face near-peers and/or enduring and persistent, global ideological networks, engagement effects are transitory and exploitation is difficult. It is easier to *deny* than to *compel*; engagements are fast but campaigns are protracted.

PROJECTION (2017): “Major power conflict will increase ... not as means of achieving victory over the enemy, but to reach specific and limited objectives, including:

- Subjugating a country by posing a direct external threat to its territorial integrity
- Violating territorial integrity with the help of local armed opposition groups
- Depriving a country of its economic, military-industrial, and geopolitical assets.”

Global Risks 2035: Search for a New Normal
Atlantic Council (2017)

WMD Proliferation. At mid-century, there are more WMD powers – nuclear and nonnuclear, state and non-state -- than at any time in history. Military planning must account for nuclear weapons, fissile materials, and chemical weapons, as well as novel and very dangerous biological weapons derived from revolutionary advances in commercial biotechnology. WMD proliferation is destabilizing as WMD “haves” coerce the “have-nots.” Have-nots race to develop their own deterrent capabilities, or seek the shelter of a great power. Several states have not only secured WMD forces for rudimentary deterrent effect, but have achieved credible and diverse retaliatory strike capabilities. Daunting in its own right, nuclear proliferation complicates conventional operations: dual-purpose platforms and command links pose serious escalation risk and complicate engagement decisions.

Complex Terrain the Norm. Dense urban areas have historically challenged land forces, but in mid-century they are far more pervasive. Urban environments sprawl horizontally, vertically and socially, posing both challenges and opportunities. Land forces must operate in these areas for sustained periods – and now view such operations as the default expectation, vice the exception. Some resort to the ‘control by devastation’ urban techniques of previous decades; others seek very precise, low collateral damage combat. Cities have massive resources that can be directed for war, such as computer controlled machine shops, 3d manufacturing facilities, small scale chip foundries, and a dense array of consumer electronics, wireless nodes, and commercial and private fiber networks. There is a premium on the ability to separate combatants from non-combatants in dense urban environments; forces employ sophisticated human and cultural mapping, biometric assessment and tagging at long range, and the ability to understand and selectively control city services and utilities.

Hybrid Combatants. Competitors combine regular and irregular forces, paramilitaries, terrorists, criminals and others to threaten strikes, raids, insurrection, information operations or outright invasion when possible or advantageous. States integrate manipulation of economic, financial, and political institutions to coerce, destabilize and unbalance target states and societies around the world. These hybrid operations are even more successful when they are augmented by conventional and WMD- escalation

strategies that deter or dissuade targets -- and their would-be partners.

Global Operational Challenges

Unlike the regional focus of the early century, Contested Equality Era operational challenges have an inherently global dimension.

Competing Great Powers. Land forces confront great power competitors with global reach. Cultural great powers based on transregional ideologies are capable of projecting considerable power as well. Usually separated by vast geographic distances, they project power from a substantial and extensive base leveraging demographic / economic advantages, technological prowess, and a far-reaching communications and transportation infrastructure. The global reach of multiple competing great powers is a recognized fact in the international environment. The relative parity of the size, reach and lethality of great powers minimizes opportunities for rapid and decisive conflict resolution.

- Global Operational Challenges
- Competing Great Powers
 - Global Competition in the Cognitive Dimension
 - Global Battlefield Extended in Depth, Domains, and Scope
 - Competitive Global Deployments
 - Diverse Mission Partners in Multiple Domains
 - Deterrence – Both Conventional and Nuclear – Compromised
 - Global Stability Operations Persist

Global Competition in the Cognitive Dimension. Era of Contested Equality competitors engage in a fight for information on a global scale, engaging with well-crafted ideas and narratives combined with pervasive and globally-reaching cyber, electronic warfare, information operations, and psychological warfare tools that can “range” core elements of opposing social and political systems. Coercion

PROJECTION (2015): “Purposeful resistance to the American-led status quo is not new. New, however, are the number of actors simultaneously empowered to resist U.S. influence effectively, the variety of routes and vectors from which they can threaten harm to core U.S. interests, and, finally, the volatility of an international system under persistent seismic pressure from the competing forces of integration and disintegration.”

U.S. Army War College SSI, *Outplayed*

through the cognitive dimension is not only possible, but often the first (and decisive) recourse in conflict, and is an ongoing, persistent activity between opposing powers within targeted societies. Land forces contribute to perception management in the cognitive dimension as a core element of military operations.

A Global Battlefield Expanded in Depth, Domains and Scope. Land forces must now address a battlespace expanded in many ways. The battlefield exhibits global depth, reaching across theaters back to respective homelands. Land forces affect – and are affected – across all domains. Warfare’s scope now encompasses continuous subversion of states, the activation and direction of local irregular proxy forces and global media, information warfare, lawfare, and cyber-attacks. The scope of warfare’s lethality is similarly expanded by massed precision munitions, smart mines, robotic

swarms, nuclear warfare, biological and chemical attack, and wide area electromagnetic interdiction.

Competitive Global Deployments.

Unlike the early century, multiple competitors now deploy to expeditionary theaters via the global commons. Theater points of entry are heavily contested by cyber, electronic warfare (EW), and long-range fires. Adversaries with established and effective anti-access / area denial (A2/AD) envelopes expose land forces to withering fire should they attack into the teeth of these defenses. Land forces must close with enemy forces over strategic distances without suffering unacceptable losses or degraded tempo.

PROJECTION (2014): “The proliferation of precision munitions and the battle networks that support them are increasing the effective range of military units. The introduction of guided munitions at all levels of operation will mean that military units can hit what they can see and that they will be able to do so from farther and farther away. U.S. forces have had to deal with the proliferation of precision munitions in the air and maritime domain for some time, but it will pose increasingly serious challenges for ground forces as well. The introduction of precision-guided rockets, artillery, mortars, and even bullets will make ground combat far more lethal ... This dynamic will increase the ranges at which opposing forces first engage in violent action across all operating domains.”

CNAS “While We Can: Arresting the Erosion of America’s Military

Diverse Mission Partners in Multiple Domains. Contested Equality Era wars are not fought and won by armies alone: land forces integrate their efforts with joint, interagency, international, and multinational partners. Forces must protect the societies and infrastructure that sustain combat, as adversaries can engage each at global range. Expanded competition short of conflict challenges land forces to work with a wide range of mission partners to strengthen resistance and harden societies against subversion from state hybrid forces and transregional threat networks. Moreover, mid-century warfare requires the support of massive industrial capacity and infrastructure -- most of which is deeply connected to the wider global economy. Land forces must maintain technical advantages while still leveraging commercial capabilities and technologies, and the raw industrial power required to sustain protracted combat operations.

All powers wish to join the contest with the greatest possible number of highly capable partners. The ability of land forces to improve partner capacity remains an important requirement in mid-century warfare. During the Era of Contested Equality, partners can be states, but also a wide range of sub-state irregulars, cyber actors, NGOs and international institutions, and -- on a continuous, and ever shifting basis -- interest and pressure groups within the information realm of conflict.

Deterrence – both Conventional and Nuclear – Compromised. In Era of Contested Equality peer competition, to win is to deter; victory in combat – with its immense costs – is a mere consolation prize.⁵³ Military forces must address the impact of increasingly linked conventional and nuclear deterrence as competitors field high end military capabilities and integrate complex political and economic networks into regional security architectures. During the Era of Contested Equality, even smaller regional competitors possess strategic deterrent capabilities, including nuclear weapons, offensive cyber

systems, counter-space, and precision conventional strike assets that constrain their adversaries' freedom of action.

Land forces must strengthen conventional deterrence by providing national decision makers and joint commanders effective options to prevent, halt, or reverse aggression. The ability to protect the force, from nuclear deterrence through tactical protective measures in electronic warfare, defensive lasers, active protection systems, and advanced integrated air defense systems (IADS) must change the decision calculus of competitors. Shaping and preclusion operations assume an important role as forward-based land forces position and maneuver to pose credible denial to aggressors, vice simply deterring them through the threat of punitive action.

Global Stability Operations Persist. Land forces still conduct military governance and peace enforcement missions around the world in support of global order. During the Era of Contested Equality, historically successful military to population ratios are difficult to achieve over large distances. Land forces attempt to conduct global stability operations more efficiently than in the past, and are working to apply virtual reality, remote presence, and robotic systems to the task. There is still no substitute, however, for human presence in any contest for hearts and minds.

Theater Operational Challenges

Although the Era of Contested Equality features a range of broad global operational challenges, military forces continue to compete – and clash – at the theater level and below.

Technological Peers with Regional Advantage.

In the Era of Contested Equality, no one nation has an overwhelming technological advantage.⁵⁴ Significantly, in this period the very notion of “peer competitor” is problematic. Non-state entities can generate very competitive effects ... and on a global scale. Inferior competitors, fighting within their region and over shorted lines of communications in the contested commons can seem very “near-peer.” Land forces must deter and defeat technologically sophisticated, sometimes numerically superior, peers capable of delivering existential-level damage to their homelands. Given this overall technological parity weapons systems must be carefully employed in schemes that maximize their advantages while minimizing their vulnerabilities.

Theater Operational Challenges

- Technological Peers with Regional Advantage
- Sophisticated IADS and Theater Conventional Strike
- Cross Domain / Cross Dimension Integration
- Urban Campaigns
- Adversary Expeditionary Maneuver
- Nuclear Powers with Escalatory Options

Sophisticated IADS and Theater Conventional Strike. Many adversaries, and not only great powers or states, have invested in A2/AD capabilities to strip away air and maritime support to land forces and to strike at ground targets at great range. Integrated aerospace defenses (IADS) defeat most airborne platforms and can destroy

satellites in low earth orbit, and even interfere with satellites at higher orbits. Era of Contested Equality land forces must penetrate, infiltrate, breach, or disrupt layered adversary A2/AD systems to unhinge adversary defenses and develop opportunities for exploitation by forces in other domains.

Cross Domain Integration. As sensors, networks and weapons extend their reach and effectiveness, effective cross-domain integration is a daunting operational challenge. Mid-century warfare presents an unprecedented array of cross domain combinations and unique methods to integrate land, sea, air, space, and information capabilities. The reach of modern systems makes this both a tactical and regional challenge.

Urban Campaigns. In the Era of Contested Equality, major urban spaces are integral to the battlefield and cannot be isolated or easily bypassed. Land forces must be prepared to fight into, inside, and from dense urban areas (DUAs). Urban environments pose both challenge and opportunity. Mid-century urban food, water, electricity and information distribution networks are more exquisite but equally more vulnerable to disruption – with the potential for catastrophic human suffering.

PROJECTION, 2016: “In the future, we’re going to have to optimize ourselves for urban combat ... Can tanks elevate their guns to near vertical? Can UAVs fly down alleyways? Can radios communicate through multi-story buildings? How do we develop intelligence inside underground areas of a city? How do units and people move and maneuver? How do you do target discrimination and identify friend from foe from non-combatant? ... Army operations in complex densely populated urban terrain is the toughest and bloodiest form of combat, and it will become the norm, not the exception, in the future.”

CSA GEN Mark Milley

Urban verticality and subterranean infrastructure complicate land force operations, freedom of movement, and force protection. From an opportunity perspective, cities are completely instrumented by a vast array of cheap and connected sensors measuring traffic, human, and material flows. Combatants have access to working electrical systems, power generation, cell phone networks, computers, mesh and other wireless networks. Concealed 3D printers throughout a DUA can “grow” autonomous threats bots that harass bypassing forces or logistics elements. Land operations may originate sustain themselves from large urban environments on an expeditionary basis.

Adversary Expeditionary Maneuver. There are now multiple expeditionary powers, and most can project “forward A2/AD zones” to preclude other forces from entry into a targeted region. A key element of mid-century expeditionary operations is to create a fait accompli and defend an ‘expeditionary lodgment’ from being defeated and expelled by another power. Facing an array of capable, expeditionary powers, Era of Contested Equality land forces must account for the relative speed – and geographical advantages -- of competitor deploying forces. Armies leverage advanced lightweight materials, multifunction metamaterials, deployable 3d printers and advanced robotics systems -- including logistics transports -- to maximize delivery of timely combat power.

Nuclear Powers with Escalatory Options. In the Era of Contested Equality many states field capable and diverse strategic nuclear deterrents as well as a range of

tactical nuclear weapons. Land forces contend with regional nuclear powers who view nuclear weapons as a viable offset to conventional force inferiority, and threaten to vertically 'escalate to de-escalate' a crisis. Alternative payloads (conventional / WMD) complicate the suppression of theater fires. Adversaries in an expeditionary environment, moreover, are more inclined to resort to WMD options on non-homeland territory.

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IV. The Character of Warfare in the Era of Contested Equality: Competitions

REFLECTION (2050): “As the period of Prelude gave way to the great powers Era of Contested Equality, their simultaneous attempts to address military operational challenges generated a series of interactive competitions. These competitions, albeit timeless, now reflect strategic environment trends and technology advances so extensive – and pervasive -- that they collectively manifest a distinct character of warfare.”

Anon: “The History of the Era of Contested Equality”

Finders vs Hiders

As in preceding decades, that which can be found, if unprotected, can still be hit – but in the Era of Contested Equality it is very hard to not be found. Most competitors can access space-based surveillance, networked multi-static radars, surveillance drones in a wide range of form factors, and a vast array of sensors that are far cheaper than the technology and techniques that defeat them.⁵⁵ These ubiquitous *finders* extend to the civilian sector, where commercial imagery services, a robust and now quite mature Internet of Things, and unlimited processing power generate a battlespace of ubiquitous *finders* and an unprecedented level of global transparency.

Hiding is possible, but “not yet found” is no longer the default battlespace status. Nano-materials and advanced material science can increasingly absorb or redirect electromagnetic energy, but such designs are expensive and only partially effective. Quantum-based sensors, for example, have extraordinary resolution. Hiding from advanced sensors requires dramatic reduction of heat, electromagnetic, and optical signatures.

For a *hider* to defeat a *finder*, it generally must not move or emit. Tactical techniques augment technology solutions, such as going to – and below – ground, or “hiding in the open” through dispersion, or near-constant relocation. Canny competitors monitor their own emissions in real-time to understand and mitigate their vulnerabilities in the “battle of signatures.” Large urban areas are attractive to combatants seeking to hide and take advantage of the overhead cover of extensive underground spaces, and urban clutter’s relatively high noise-to-signal ratio.

The Era of Contested Equality Competitions

- *Finders vs Hiders*
- *Strikers vs Shielders*
- *Range & Lethality vs*
Close Engagement & Survivability
- *Disconnection / Disaggregation / Decentralization*
vs Connection / Aggregation / Centralization
- *Offense vs Defense*
- *Planning & Judgement vs Reaction & Autonomy*
- *Escalation vs De-Escalation*
- *Domain vs Domain*
- *Dimension vs Dimension*

In the *finder* versus *hider* competition, passive sensing -- especially when combined with AI-based signal processing and big-data techniques -- routinely outperforms active sensing. Active sensors reveal the *finders* position, while non-emitting passive sensors are difficult to detect and demand relatively lower energy levels. Active sensors, when employed, no longer rely on brute high power but rather intermittent, highly directional pulses with low probability of intercept.

The complete destruction of ubiquitous sensors is not feasible. High-powered microwave (HPM) systems can clear limited corridors, but more often advanced techniques attempt to deceive *finders*, vice destroy them. Unlike early jammers that used pre-planned techniques against known EW threats, cognitive, autonomous EW assets assess signals and develop real-time active countermeasures during engagements.

A renaissance in the art of CC&D (Camouflage, Cover & Deception) emerges in the *finder* versus *hider* competition. Obscurants, physical decoys, and camouflage are employed where possible to prevent identification, classification and tracking.⁵⁶ The art of CC&D, moreover, extends across multiple domains. Tactical combatants both *find* -- and *hide* from -- threats in other-service domains, including space assets now available to target tactical platforms, and cyber assets used to locate *hiders* and spoof *finders*. Land forces are relatively advantaged in this cross-domain competition, and for multiple reasons. Their innate ability to leverage land clutter allows them to conceal and preserve key assets -- such as operationally responsive space nano-satellites or advanced components of integrated air defense systems -- until the moment of need. When ground forces close, moreover, they cause *hiders* to move, shoot or communicate -- activities which expeditiously terminate their 'not yet found' status.

PROJECTION (2016): "... no matter where you go in the world today, it's observable from some device. The ability to surveil, to see and communicate, is at levels never before seen in human history. Almost everyone and everything is a potential ISR platform capable of transmitting real-time information, that if properly analyzed can be useful intelligence which can significantly help or seriously hinder military decision-making and operations"
CSA GEN Mark Milley

Strikers vs Shielders

The finder-hider competition is fundamental because of the simultaneous maturation -- and proliferation -- of the precision strike regime. The type of precision formerly reserved for high end aero-space assets is now extended to all domains and at every echelon of engagement, including the individual Soldier. Combatants -- including many non-state entities -- leverage multiple manifestations of precision strike: kinetic weapons, hyper-kinetic weapons, directed energy, EMS, and cyber. With operational reach ranging from tactical to global, the application of their impact from one domain into another is routine. Their effects scale, moreover, from subtle cyber neutralization to catastrophic nuclear detonation. *Striker* techniques include both point precision and

area suppression: where *hiders* are particularly effective, *strikers* resort to area suppression weapons such as thermobarics and cluster munitions, delivered accurately but over extended ranges.⁵⁷

Peer competitors cannot long endure the application of such *strike* effects, particularly when directed by robust *find* capabilities. Successful combatants devise *shields*: joint, combined arms endeavors that target opposing *finders*, their linkages to *strikers*, or the *strikers* themselves. For every manifestation of *striker*, there is a *shielder* counterpart: intercept missiles, railguns, lasers, jamming. The art of the shield between peer competitors, however, is the allocation of such assets -- in

PROJECTION (2016): “We are also in the midst of major change in lethality and the proliferation of precision munitions to most nations, and varying degrees of quality and quantity. Lethality against fixed and rotary wing aircraft has also advanced significantly in the last few decades, so air space can be denied even to the most sophisticated and expensive aircraft. Land and sea-launched ballistic missiles have proliferated throughout the world, and land, air, and sea-launched cruise missiles have done the same, to deny either the maritime or air domains. What was once the exclusive province of the United States military is now available to most nation-states with the money and will to acquire them.”

CSA GEN Mark Milley, 2016

locations, at ranges, and against targets -- that maximize their relative effectiveness. Some assets, such as rail guns or lasers, have virtually limitless magazines but are tethered to robust power sources.⁵⁸ Other assets trade speed and agility for range. *Shielders* are generally most effective in point or localized defense and this generates a battlespace geometry of isolated, combined arms, non-contiguous shields protecting key assets and formations – surrounded by vast, non-shielded areas.

The ensuing *striker-shielder* competition contributes significantly to the Era of Contested Equality’s character of warfare:

The Rise of Relative Range. The *striker-shielder* challenge is irretrievably tilted to the combatant with range advantage: combat developers trade off range at their peril. Extended range brings more *strikers* to bear, and no “*shield*” is more effective than stand-off range.

The Salvo Competition.⁵⁹ In a great power *striker-shielder* salvo competition, strikers must increase the size and pace of their attack salvos. This requires using smaller weapons carried in larger numbers by strike platforms.

Munition Protection: Hardening and Speed. Whereas at the dawn of the precision revolution the probability of kill was largely a function of munition precision, the maturation of robust shields complicates munition delivery. Select munitions incorporate hardening for resistance to directed energy or EMS attacks, or integrated jammers and decoys on the munition itself.⁶⁰ Alternately, hyper-kinetic weapons rely on speed to outmaneuver interdicting systems. Expensive to produce, these are reserved for priority targets.

Swarming. Era of Contested Equality technology enables massed, low cost, self-organizing unmanned systems directed by bio-mimetic algorithms that literally “swarm” and overwhelm *shielders* with an onslaught of “the small, the

smart, and the many.”⁶¹ Effectively expendable, reductions in the protection needs of such systems further reduce size, weight, complexity and cost.

Competing Cost Curves. Successful peer competitors cannot long ignore the bend in engagement cost curves. Exquisite munition saturation attacks against decoy targets, for example, are disastrous. Due to the scale of this great power competition, cost-tradeoffs accumulate dramatically and strategic success goes to the competitor who designs, builds and allocates combat systems to operational roles that best leverage inherent physical and cost advantages.

Range & Lethality vs Close Engagement & Survivability

The Striker-Shielder competition illustrates the Era of Contested Equality benefits of range and lethality to penetrate and overwhelm a shield – or, conversely – shield against strikers. A complementary approach is *close engagement*. Close engagement disintegrates integrated defenses, causing concealed forces to unmask and uncover, exposing them to the finder and striker dynamic. The most effective approaches combine these two approaches – and from multiple domains.

The challenge is the approach. *Close engagement* forces need superior range and lethality, but they also need *survivability*: the protection (and mobility) that allows them to maneuver through denied areas to close with and defeat the highly lethal assets securing the adversary shield. Thus ensues the competition between *range and lethality vs survivability and close engagement*.

Peak Passive Armor. Close engagement is a daunting challenge in our era when kinetic energy routinely overpowers passive armor. Nanotechnology has improved material blast resistance, but passive protection is outpaced by kinetic threat enhancements – including nanoenergetics. Passive armor is required to defeat many battlefield threats, but passive armor is a mobility trade, and – since passive armor is no longer a complete solution -- in the Era of Contested Equality great powers are more willing to make that trade.

Survivability Trades. As protection became less feasible for land platforms, they logically followed their predecessors in the air domain and traded passive protection for mobility, speed, and the safety of remote controls. The disaggregation of armored combat vehicle platforms and manned-unmanned teaming (UMT) for both sensors and strikers has enhanced initial engagement survivability in a highly lethal battlespace.^{62 63}

PROJECTION (2016): “... the scope of robots in military operations is not yet widespread, and that is likely to change in the very near future, as unmanned fighter bombers, unmanned surface and subsurface naval vessels come online. And we are likely, very likely to see the increased use of robots in ground operations as the technology matures.”

CSA GEN Mark Milley

Boundary Effect Mobility. Ground forces struggle to retain options for agility via air movement in the face of daunting enemy integrated air defenses. Nap of the earth flight – enabled by robotic controls to be much faster and far closer to

the ground-air boundary -- becomes the only feasible environment for rapid land force agility within the coverage of an enemy IADS, and then only at some risk. Affordable individual air mobility – albeit at limited range -- emerges as a gamechanger that trades speed and mobility for protection, but thereby offsets one of the principle liabilities of the dismounted Soldier, particularly in the urban area ‘vertical’ environment.

Primacy of Position. Favorable position, particularly well-prepared positions, are highly advantageous. Those who must move – particularly over strategic / operational distances, are significantly disadvantaged. The advantage of passive sensing, moreover, puts a premium on preparation of the sensor battlefield.

Mass and Attrition. In peer competitions where domain supremacy or even superiority is neither assured nor sustained, *lethality* and *range* resurrect the classical considerations of attrition and culmination. Quantity regains the “quality all its own.” The principal of mass regains its prominence on the battlefield, but in a totally different ideal: the massing of *effects* vice the concentration of *assets*. Enabled by advanced additive manufacturing techniques, some competitors – particularly non-state actors – eschew exquisite multirole platforms in favor of large numbers of single function, autonomous assets able to work in concert.

Disconnection / Disaggregation / Decentralization vs Connection / Aggregation / Centralization

Two contradictory trends drive the configuration of forces in the Era of Contested Equality battlespace. On the one hand, consolidation of forces enhances their connectivity, aggregation, and control. Such consolidation reinforces the strength of the shield and ability to mass effects. On the other hand, such consolidation poses extreme risk and there is a countervailing impetus to *disconnect* – to the extent possible -- from global sensing networks, *disaggregate* formations, and accept significantly *decentralized* control.

In this competition, great powers confront the trade between control and risk. Many resort to agile combinations of these approaches: operational key terrain may mandate *consolidation* for retention and control; unfavorable correlation of capabilities may dictate dispersion and *disaggregation* for survivability. Such combinations demand flexible, scalable force structures that can accommodate joint and combined capabilities disaggregated to extremely low levels -- or aggregated without loss of efficiency. The need for super-enabled small units reinforces the need for innovative approaches to generating joint and combined arms synergy.

PROJECTION (2016): “The battlefield will also be non-linear, compartmented, and units will have non-contiguous battle space with significant geographical separation between friendly forces. This type of battlefield will place a very high premium on independent relatively small formations that are highly lethal and linked to very long-range precision fires ... just to survive our formations, whatever the wire diagram looks like, will likely have to be small. They will have to move constantly. They will have to aggregate and disaggregate rapidly.”

CSA GEN Mark Milley

Non-contiguous battlefield geometry shapes two key contests:

- **The Contest to Communicate:** persistent and pervasive attacks on communication networks in all domains (including the space segment and local networks through integrated electronic warfare, laser, HPM and other means), disrupt communication wherever possible: organization-to-organization, man-to-man, man-to-machine, machine-to-machine. The contest to communicate is particularly crucial for organizations compelled to disperse and disaggregate, but it is simultaneously in tension with the dynamics of the hider/finder competition. Competitors seek assured communication through redundant, heterogeneous networks employing innovative techniques including low power and highly directional transmissions over multiple portions of the electromagnetic spectrum.

Cyber power demonstrates a capability / vulnerability conundrum: the greater the reliance on advanced cyber capabilities, the greater vulnerability to disruption, diversion, and destruction. Paradoxically, then, disconnection enhances communication assurance (and hiding) to the extent that it can isolate units or areas from external, hostile interference. Units frequently “go dark,” eschewing connection and access to external resources to facilitate security and *internal* communication assurance. In the Era of Contested Equality, however, connection is the default condition and “disconnection” is only feasible if it is a design feature of supporting networks and systems. Some competitors even incorporate spatial network boundaries into their domestic infrastructure, but much of the world is wired with irreversible legacy connectivity that cannot be readily severed.

- **The Struggle to Sustain:** Non-contiguous battlefield geometries pose daunting land force sustainment challenges. Sustainment is no longer a continuous background function over linear lines of communication, but rather an overt, integrated combined arms activity that pulses and protects support packages across non-contiguous battlespace. A successful sustainment pulse resets a unit’s “expiration clock,” but that clock resets and inexorably counts down until the next sustainment pulse is required. AI can assist in predictive logistics management, but logistic support is still required. Major logistic hubs are prime candidates for robust shields – or, where necessary – innovative dispersed and mobile logistic asset configurations. The complexity of this challenge matches the level of disaggregation, but the scale is global as commons are contested and threats extend all the way to the Homeland.

“The sustainment challenges will be significant. Life will almost certainly be extremely austere. Water, chow, ammo, fuel, maintenance, and medical support will be about all that should plan for ... and our lines of communication will for sure be contested, and probably denied. Being surrounded will become the norm, the routine, the life of a unit in combat. In short, learning to be comfortable with being seriously miserable every single minute of every day will have to become a way of life for an Army on the battlefield that I see coming.”

CSA GEN Mark Milley, 2016

The struggle to sustain in the Era of Contested Equality is generally won or lost in the Prelude Period: in force design. Designs that limit the sustainment demand signal are dominant in a non-contiguous battlespace. Competitors that make significant breakthroughs in the energy dimension of sustainment, either on the demand side or on the supply side through forward, mobile energy sources such as mobile nuclear reactors, reap transformational impacts on their entire force structure design.

Offense vs Defense

Offense vs Defense is indeed a timeless competition, the outcome reflecting the strategic and technical conditions peculiar to each era. In the Era of Contested Equality, at least in the land domain, those conditions favor the defense. With peer competitors robustly – but equally -- equipped with *finders* and *strikers*, the combatant who moves – particularly over extended strategic and operational distances -- is disadvantaged. A defensive stance favors the development of more effective *shields* with robust passive sensors (finders), and offers the advantage of hardened, redundant locations in the *lethality vs survivability* contest.

This inherent advantage shapes the strategy and policy of competitors leading up to and through the Era of Contested Equality. Unanticipated strategic surprise is heavily rewarded if it rapidly presents unprepared adversaries with *faits accomplis*. The old methods of deterrence by *reversal* – punishment of aggression -- are impractical against adversaries presenting new facts on the ground and protecting those facts with a defensive stance. Deterrence by *denial* is now preferred. Therefore, even more than during the Cold War, adversaries pursue forward presence in potential regions of conflict, particularly a forward presence that support a prepared operational defense and its consequent advantages.

PROJECTION (2014): “It is ... plausible that fundamental changes in how the U.S. military plans to fight will have to be made in order to cope with a future in which precision strike— nuclear as well as non-nuclear— produces “no-go” areas even more lethal and costly than the machine gun and massed artillery rendered trench warfare during 1914-1918.”

CSBA: Evolution of Precision Strike

Perversely, the *offense vs defense* competition inverts in the information dimension of conflict. Here, offensive information action is generally ascendant, and indeed can set the conditions to overcome defense advantages in the physical realm. The ideal offensive scheme is one beginning with a sustained information campaign that sets the conditions for a surprise, rapid *fait accompli* in the physical realm that can be preserved through follow-on defensive action.

The ultimate necessity to seize the initiative and take offensive action at some level still endures as intrinsic to the nature of the war. The challenge is to address warfare’s unique character in the Era of Contested Equality so as to leverage the defense when available and make offensive action feasible where necessary.

Planning & Judgement vs Reaction & Autonomy

The duel for initiative is inherent to the nature of war, but this duel has a unique character in the Era of Contested Equality. Operational tools offer extraordinary speed and reach, and not infrequently precipitate unexpected consequences. The planning paradox in the offense is that rapid execution depends on very careful planning and condition setting, particularly in the cyber domain. On the defense, however, faced with bewilderingly short reaction windows, many resort to automated – and increasingly autonomous – decision processes. Taking human beings “out of loop” poses potential advantages versus competitors unwilling or unable to automate key decision processes.

There is, of course, a balance, with each competitor applying a mix of these control techniques distributed across what they consider to be the most appropriate links in the decision chain. The collection and processing of vast amounts of information is trivial, but now machine learning and artificial intelligence extends historical analyses and probabilistic outcome forecasting to even the most junior staffs. The distributed machine-learning phenomenon first demonstrated in autonomous commercial vehicles is now applied to tactical engagements so that adversaries quickly learn – and adapt to -- adversary techniques. Armies no longer adapt merely between wars, they adapt between and during engagements.

Mission Command endures, but in the Era of Contested Equality's dynamic, disaggregated battlespace a Commander's original intent rarely persists for extended periods. The rapid presentation of tactical threats and opportunities rewards “Conditions Command”, a willingness to execute based on independent recognition of required conditions, rather than positive confirmation or refinement of the original mission.

Paradoxically, in an era of autonomy and artificial intelligence, human judgment is at a higher premium than ever before. Only human judgment can wield military art, but such judgment is now best generated in hybrid solution approaches that join carefully selected, educated and trained individuals with cognitive human performance enhancements. Nations are most willing to test their ethical boundaries with respect to command performance enhancement, and the transhumanism movement picks up significant momentum with initiatives ranging from widespread pharmacological aids to more aggressive DNA editing and bio-mechanical modification.

Escalation vs De-escalation

In the Era of Contested Equality, the competition between violence *escalation* and *de-escalation* is central to stability, deterrence, and strategic success. Violence is readily available to a wide range of actors, and on unprecedented scales. Conventional and cyber capabilities are so potent, moreover, that they can generate effects on the scale of Weapons of Mass Destruction (WMD).

In the run-up to the Era of Contested Equality, the challenges of the *escalation / de-escalation* competition had been evident for decades. The original essence of “Gray Zone” warfare was escalation competition: the assertion of willingness to escalate a conflict to a level of violence that exceeded the interests of an adversary. At the dawn of Gray Zone operations, many adversary decisions were complicated by over-simplistic decision triggers related to ‘levels of violence’ and outdated categories of ‘war’ and ‘peace’. Over time understanding has evolved to a more subtle understanding of how cyber effects can devastate without overt violence, and how disparate non-violent activities can quickly compound to significant strategic consequence.

The erosion of counter-proliferation regimes during the Prelude Period has resurrected a Cold War term: Integrated Warfare. This is the routine planning for – and execution of – integrated nuclear and conventional warfare. Therefore the *escalation / de-escalation* competition brought to pass a 2016 estimate:

“The distinction between the lethality of conventional and irregular forces is becoming less profound. The “blurring” occurring between conventional and irregular warfare is matched by the progressively narrowing “firebreak” between conventional and nuclear warfare, as precision-guided weaponry and cyber payloads become more capable of substituting for nuclear weapons under certain conditions, and as nuclear powers ... design low-yield nuclear weapons to offset their vulnerability to advanced conventional warfare.”⁶⁴

Long range strikers – taken together with cyber technology and ever more ubiquitous finders -- are significantly destabilizing in that they expose the linchpin of deterrence in the Prelude Period: survivable, mobile missiles. This ratchets up the rewards for shooting first, lowers the tolerance of reactive intelligence and decision processes, and lowers the confidence in reduced nuclear arsenals. Escalation Advantage becomes a prominent feature of force design, doctrine & policy across all the great powers.

Domain vs Domain

In the Era of Contested Equality, competition extends and intensifies in new domains, particularly space and cyberspace. Each domain is fiercely contested, and between great powers lasting dominance or even assured superiority in any domain is elusive. As the tools of warfare extend their physical capability to both *find* and *strike*, armies decreasingly constrain their planning and operations merely to the land domain. Each domain’s unique physics still

PROJECTION (2016): “Dominance of the air by the United States Air Force, which the Army has enjoyed since the Normandy landings in 1944, will no longer be a luxury that we can assume in the next war. That means our units are going to have to be combined arms, multi-domain capable. We will still have to fight and destroy land-based enemy units and seize terrain, but the Army, yes, the Army, we’re going to sink ships, and we’re definitely going to have to dominate the airspace above our units from hostile air or missile attack ... our Army will maneuver in all of the domains to gain temporal advantage, enable the joint force freedom of action to seize the initiative ... we will employ our great mobility, we will employ our advantage in fires, both long-range and close, and we will conduct cross-domain fires ... land forces will, both horizontally and vertically, integrate all of the joint force in all of the domains, and it will be armies that will be central to winning future wars.”
CSA GEN Mark Milley

constrains platforms and techniques, but the highest art of combined arms warfare is to generate effects from one domain against another: leveraging their relative advantages and mitigating their innate vulnerabilities. Land forces must contribute to the provision of temporary windows of advantage in all domains.

“We need a degree of jointness, in my opinion, in which no one military service dominates and no domain has a fixed boundary. A combatant commander must be able to create effects from any single domain to target in every domain in order to fight tonight and win. [I need] a true land-based cross-domain capability [that] offers us an integrated joint force capable of deterring rising powers by denying them the domains in which they seek to operate.”

Admiral Harris, PACOM Commander

In this environment, effective joint synergy is not a bonus, it is table stakes for survival. The complexities of generating such synergy across multiple domains impose daunting education and training requirements at progressively lower tactical echelons in all the services. Increasingly agile C2 systems, underpinned by compatible data networks, must simultaneously accommodate the range of maritime functions, the speed of

air / space / cyber operations, and the tactical complexity of land warfare.⁶⁵

Dimension vs Dimension

At the dawn of the information age, most competitors readily appreciated the potential of information technology to accelerate and amplify military effectiveness in the physical realm of conflict. Most competitors were slower to appreciate that the ubiquity, accessibility and reach of information tools would accelerate and amplify the informational, cognitive dimension of conflict itself. The 2017 NIC forecast was accurate:

“... warring will be less and less confined to the battlefield, and more aimed at disrupting societies – using cyber weapons from afar or suicide terrorists from within ... Future conflicts will increasingly emphasize the disruption of critical infrastructure, societal cohesion, and basic government functions in order to secure psychological and geopolitical advantages, rather than the defeat of enemy forces on the battlefield through traditional military means. Noncombatants will be increasingly targeted, sometimes to pit ethnic, religious, and political groups against one another to disrupt societal cooperation and coexistence within states.”⁶⁶

By the dawn of the Era of Contested Equality, there is widespread understanding that conflict is a competition, not only across every domain in the physical dimension, but also the cognitive dimension, and even the moral dimension of belief and values. Adversaries – equally enabled by ubiquitous sensors, big data techniques, responsive space satellites and robust social media access -- enjoy competitive levels of situational awareness. Information is weaponized, directly through cyber techniques or implicitly through social media techniques.⁶⁷ There is a recognized premium for understanding and appreciation of the belief systems that motivate actors in the moral dimension of conflict. Successful competitors recognize this competition between and across the dimensions of conflict, and hold ‘narrative’ in equal regard with ‘networks’ or ‘nukes’.

In the Era of Contested Equality, terms like Regular and Irregular Warfare have lost their categorical cachet. Peer competitors combine alternating combinations of these approaches, or hybrid amalgamations of both. The spectrum of conflict ranges from peaceful, legal activities through violent, mass upheavals and civil wars to traditional state-on-state, unlimited warfare. Engagements are both symmetric or asymmetric and encompass tools across all the dimensions of conflict: advanced weapons, insurgency, terror, cyber warfare, information warfare, political warfare, and diplomacy.⁶⁸

PROJECTION, 2016: “Adversaries increasingly use economic coercion, political influence, unconventional warfare information ops, cyber ops to advance their interests and they do it in a way that they know we don’t have an effective response. They, unlike us, are able to integrate the full range of capabilities their states possess to advance their interests. Our traditional approach where we are either at peace or at war is insufficient to deal with that dynamic. The current reality is more an adversarial competition with a military dimension short of armed conflict.”

General Joseph Dunford

There is, therefore, a premium on effective integration across all elements of available power: diplomatic, informational, military and economic and the *dimension* competition indeed constitutes a ‘clash of cultures’. One culture may not be more legitimate than another; a culture can, however, be more effective in conflict. The Era of Contested Equality plays out severe ethical asymmetries with respect to the limits

of allowable human performance enhancement, permissible levels of control for artificial intelligence and autonomous systems, delegation of authorities for cyber attacks, the legitimacy of terror tactics, and a willingness to put noncombatants at risk through WMD use or conventional means with equivalent impact. Over time, it is the victors – not the lawyers -- who define what is “right.”

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V. The Drivers of Outcome

REFLECTION (2050): “In the Contest between great powers -- unlike previous eras -- determinants of outcome were rarely economies or technologies. Such resources were shared by multiple combatants and did not constitute disproportionate advantage. This was a struggle between “peer” or “near-peer” competitors who -- because of either global reach or geostrategic advantages within their region -- were able to contend on a generally equal footing.

To be sure: although their aggregate levels of power were equivalent, their capabilities were far from symmetric. They were in no way mirror images, but rather reflected the collective consequence of a series of decisions dating back to the Prelude Period and before. These decisions were each power’s attempt to address their estimate of the simultaneous, interactive competitions that would characterize warfare in the looming Era of Contested Equality.

Outcomes were contingent, therefore, on the relative quality of these decisions: the extent to which they were – compared to their adversaries – “not too wrong.” Although no single decision singularly explains the outcome of the Era of Contested Equality, five general topics are particularly relevant:

- Strategy and Policy
- Concepts
- Adaptation and Innovation
- Combinations
- Learning

This is where conditions were set that ultimately determined the outcome of the simultaneous, interactive competitions that characterize the warfare of our time.

Anon: “The History of the Era of Contested Equality”

Strategy and Policy

In the Era of Contested Equality, perfect tactics and brilliant campaigns can still not rescue bad strategy. Successful great powers anticipate the character of the competitions of warfare and set conditions for advantageous outcomes when warfare occurs; the *most* successful set conditions so effectively they preclude warfare as adversaries are deterred or acquiesce. Effective competitors view strategy as an art vice a periodic, recurring process, and are careful to continuously revisit their strategic assumptions. Those assumptions, for example, have evolved significantly since the Prelude Period. Wars are not presumed to be short and conventional. No logical combatant anticipates permissive operating conditions or sustained superiority in any domain. Space is not viewed as a sanctuary and communications networks are not

‘assured’ with respect to performance or security. Technological advantage is not viewed as assured or enduring. Commercial logistics do not underpin sustainment solutions that must address noncontiguous, contested battlespace.

Legacy strategic notions endure, but their emphasis evolves. In great power contests where economic and technology gaps are narrow, geographic position and strategic depth regain status as dominant considerations. Strategic depth can be reinforced by forward positioning; such forward positions leverage the inherent advantages of the defense. Such positions also support the transition to ‘deterrence by denial’ vice ‘deterrence by reversal.’ The premium on forward positions rewards the great powers most effective at finding and retaining partners, either of alliance or of convenience.

Successful strategies in the Era of Contested Equality are based on realistic theories of victory that address the will and motivation of specific adversaries; therefore such strategies encompass careful estimates across all dimensions of conflict: *physical*, *cognitive*, and *moral*. Between nuclear-armed great powers, conflict is increasingly protracted and decreasingly decisive; historical strategic terms like “end state” and “exit strategy” are viewed as meaningless and downright dangerous. Strategies embrace uncertainty in a continuous – and not a cyclic -- process of managing, compromising, adapting. Given the protracted nature of conflict, successful strategies do not risk national solvency.

Most importantly, strategies address choices. The strategic choices before the great powers are daunting. Who are the most effective partners? Where, and to what extent, to commit to forward basing? How to balance between protection of partners (and forward position) and homeland protection? What policy decisions trade value beliefs against warfare competitiveness? What are the most effective – and adaptable – operational concepts?

Concepts

An operational concept is an image of combat: a concise visualization that portrays the operational challenges of adversaries and their capabilities, and the scenario by which they will be defeated. In the Era of Contested Equality, the most effective operational concepts resolutely address the dominant trends in the simultaneous and interactive competitions that constitute the character of warfare. They recognize the peer or near-peer status among the great powers, the proliferation of precision weapons, the expanding reach of sensors and weapons and the concomitant expansion of the battlefield. They understand the relative advantages / disadvantages of the available technologies and combine them for maximum leverage across all domains. Universal concepts are problematic, for an operational concept must address the strategic and regional circumstances unique to each adversary.

Effective concepts retain and build on what is timeless and enduring: joint and combined arms warfare is even more potent because of the increased potential for

cross-domain synergy. Maneuver warfare is even more prized, albeit more complicated because of the inclusion of additional domains (particularly space and cyber) and dimensions (cognitive, moral). Mission command is more challenging and even more necessary. Jointness is routinely extended to lower echelons. As always, the purpose is seizure, retention and exploitation of the initiative.

The Era of Contested Equality manifests these timeless considerations in significantly different ways. Domains are not easily sub-allocated to joint components: each service generates effects in multiple domains. Battlespace architecture is fundamentally altered as disaggregation and dispersion distributes forces widely. The fires component of maneuver is increasingly important as range and lethality compensate for the difficulty of undetected movement. C2 nodes are extremely small and alternate between continuous movement or deep hide and disconnection as their preferred survivability measure as circumstances dictate. Such periods of disconnection reinforce reliance on mission command and extend it to the notion of ‘conditions command.’

“Since the spread of the idea of the joint fight, there has always been a gray space between the domains. For example, warships have been able to project power onto the land and coastal artillery has been able to project power onto the sea. The technology of the present and near future will expand these gray spaces to the point where they will cover vast areas and even entire theaters. Consequently, the range of future land forces will be so great that distance no longer matters as a boundary between domains.”

Palazzo-McLain

Most importantly, concepts themselves are components of Contested Equality Era conflict. The most effective concepts are never exercised: they threaten disproportionate penalties to potential opponents, and present daunting challenges to adversaries while affording friendly decision makers with a range of options, both escalatory and de-escalatory.

Adaptation and Innovation

As throughout the history of warfare, the contest of adaptation and innovation endures. Competitors seek to leverage – and mitigate – disruption across a broad array of technologies and approaches. Competitors explore and exploit innovative technologies such as nano-science, robotics, manned-unmanned teaming and the artificial intelligence that enables it, quantum computing and human performance optimization.

In the Era of Contested Equality, however, these disruptors are not viewed merely as offsets for deficiencies in mass or position, since technology is broadly available to most combatants. Rather, disruptors are accelerants in a contest that anticipates significant attrition and appreciates the restored impact of quantity. Therefore superior innovation and adaptation addresses not only technological possibilities but also their timely and cost-effective transition to engineering and manufacturing. Production tools such as robotics, 3D printing, virtual reality design, additive manufacturing, predictive analytics

and a broad range of innovative and bio-mechanical processes afford the manufacturing edge that is equally disruptive in the adaptation / innovation contest. Effective competitors reinforce basic scientific research to power not only military capabilities but also broad competitive advantages for national economies.⁶⁹ They relentlessly preserve their sovereignty over advanced production facilities, recognizing the synergy between production and innovation.⁷⁰

PROJECTION (2014): “First, each and every technological edge will be fleeting. The United States enjoyed about a decade of advantage during the early nuclear era, and arguably several decades during the evolution of the guided weapons era. But adversaries will always catch up. The dynamics of the modern global economy and the accelerating diffusion of military power will compress the time during which any new military technology will give the advantage to one actor over another. Thus defense planners must assume that the emergence of any new disruptive military technology, will be met and matched within a decade.”

Shawn Brimley: “While We Still Can”

The proliferation of disruptive technology, moreover, causes competitors to be much more circumspect with respect to the timing and revelation of their innovations and adaptations. All combatants seek to minimize the time required to react to technology surprise, but in a fair innovation competition, “timing is everything.” Adversaries attempt to time the revelation of their technical advances in a manner that minimizes the ability of adversaries to react.

Such timing exercises trades between quality and quantity, since the ultimate competitive criteria is not technical superiority, but *fielded* capability superiority.

Design differentiators are particularly important. Reliability and sustainability may be the ultimate driver of outcome between technological peer competitors. Heterogeneous solutions are favored over homogeneous ones. Resilience in design is critical, not only the kind of resilience that can endure the ravages of robust enemy finder and striker regimes, but also the design resilience that enables multiple capability options. Where existing designs can be effectively repurposed, for example, then adaptation time is significantly shortened. ‘Disruptive modifications’ may be as consequential, if not more, than fundamentally new technologies.

Although technical parity is probable in our Era, the innovation contest is intense. It is always possible, that new “big things” emerge to fundamentally disrupt the character of warfare. Therefore, there is great incentive to be the first (or among the first) to identify and exploit the “next big thing” in warfare.⁷¹ What is not probable, however, is that in a world of great interconnectivity and distributed technologies the “next big thing” will lead

PROJECTION (2017): “The occasional assumption that the U.S. possesses the capability to innovate its way to regaining its traditional technological preeminence, thus ensuring continued military predominance, is inherently problematic. Today’s technological trends are not conducive to the preservation of such a decisive, undisputed edge. Because cutting-edge research and development increasingly occurs within the private sector—and the majority of emerging technologies are inherently dual-use—the rapidity of technological diffusion has increased significantly.”

Elsa B. Kania, The Strategy Bridge

to sustained and prolonged dominance for any particular power.⁷²

Combinations

Failures of *innovation* in the Era of Contested Equality are disastrous; failures of *imagination* can be catastrophic. Warfare has always been the art of combinations; in this Era's great power contest the outcome belongs to the competitor most imaginative in presenting his adversary complex, multiple dilemmas. At the national level this entails effective integration of all the elements of power: diplomatic, informational, military and economic. Combatants who fail here are severely handicapped: it is the most fundamental combination requirement: the prerequisite for success in all others.

A close second driver of outcome in the combinations contest is joint and combined arms warfare. Contested Equality Era jointness extends far beyond mere domain deconfliction. It is joint integration by design in which all services not only expect support or enablers from other domains, but each in turn routinely influences other domains. Because of both enemy threats and friendly capabilities, joint operations migrate to lower echelons of planning, command and execution. In the Era of Contested Equality the joint role for land forces evolved significantly. Land forces are now able to give as well as receive joint support. They are often viewed as more stabilizing, since forward deployed, cross-domain denial forces occupy sovereign territory of partners and cannot be attacked without significant horizontal escalation risk.⁷³ Ground forces establish, maintain, or defend "facts on the ground"; destroy, degrade or disrupt enemy forces; influence, persuade, coerce or reassure populations; or extend the operational reach of air or sea forces through the creation or reinforcement of friendly shields and areas of dominance.

PROJECTION, 2016: "Military advantage rests on a bedrock of advantage in tactical combat ... Advantage is often a combination of armament (technology) and tactics integrated into a coherent tactical system that decisively defeats an opponent's comparable tactical system...Historically, combined arms forces have been broadly more successful than those constructed around one dominant tactical system...The ability to apply a superior tactical system repeatedly against an opposing force is a critical foundation upon which military advantage is built."

Office of Net Assessment "Military Advantage in History"

The contest of combinations, of course, elevates the science of generating combined arms effects, either from a land component, joint, or multinational perspective. The synchronization challenges are now far more daunting, not only because of the additional domains that generate synergy, but because cause and effect must be orchestrated across multiple domains with very disparate considerations for speed and operational reach.

Nonetheless, the rewards of success are substantial, offering disproportionate results for successful, cross-domain synergy.

One combination challenge with little precedent emerged during the later phases of the Prelude Period and is a dominant consideration in the Era of Contested Equality: the

combination of humans and technology. Such combinations are enabled by human genetic engineering, neural implants, prosthetics; and other approaches that combine nanotechnology, biotechnology, information technology and cognitive sciences.

Learning

Learning before and during conflict is the ultimate contest. Rising competitors must overcome their inexperience in generating joint synergy across the multiple domains and dimensions of conflict. Their lack of appreciation for the challenges of Contested Equality Era warfare puts both themselves and international stability at risk. Legacy great powers must overcome the cognitive anchoring that blinds them to the impact of strategic trends, possibilities of alternative solutions and the vulnerabilities of their past demonstrated successes.

“The last decade and a half have left an indelible mark on those of us who fought; we need to ensure that that experience does not blind us to the very different circumstances that we may face. That includes developing the intellectual capacity to think about the character and conduct of war in the 21st century and to develop strategies and operational concepts to bring our enduring strengths to bear against our competitors.”

Mahnken SASC Testimony

Conflict Era competitors pursue robust wargaming and experimentation to mitigate their learning risks, but all must be prepared for robust, simultaneous operational execution and learning. Operational learning is very much a competitive sport, and if the ultimate contest is the contest of learning, artificial intelligence may be the ultimate technology: AI techniques such as neural networks and distributed machine learning facilitate learning, potentially at machine speed; information technology facilitates horizontal dissemination of lessons learned.

VI. Conclusion

It is a daunting task to forecast a future decades hence, but the challenges should not deter us. The global trends that shape how we will *live, create, think* and *prosper* – captured by the estimate of the National Intelligence Council – already have considerable momentum, much of it inexorable. These trends will generate an operational environment with distinct characteristics and challenges. Collectively, those characteristics and challenges present a series of operational tasks to all great powers who chose to compete in this operational environment.

As militaries – and land forces in particular – attempt to address these operational tasks they will engage in a complex and interrelated set of mutual competitions. Together, these competitions reflect strategic environment trends and technology advances so extensive – and pervasive – that they collectively manifest a distinct character of warfare. This character is grounded in the sophisticated combination of advanced capabilities across multiple domains and between great powers who compete on a peer or near-peer basis.

What does this portend for the U.S. Army? The ultimate drivers of outcome lie in our imminent decisions with respect to strategy and policy, concepts, innovation and adaptation, and the art of our future combinations from the interagency, joint, and operational perspective. Most importantly will be in our ability to learn, as recently cited by the Army Chief of Staff GEN Mark Milley:

“And this means to us, the Army, that every assumption we hold, every claim, every assertion, every single one of them must be challenged. War, war tends to slaughter the sacred cows of tradition, of consensus, of group-think and myopia. The next war will be no different. Those of us, or those nation-states that stubbornly cling to the past will lose. They will lose that war, and they will lose it in a big way.”⁷⁴

End Notes:

¹ An extension of the phrase VCSA Dan Allyn used in his 17 February Testimony to Senate Armed Services Committee where he described the Army as “outranged, outgunned, outdated.” Also cited in TRADOC Operational Environment Briefing (February 2017).

² Thucydides, the Melian Dialog, in Robert Strassler, *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War* (1996), p. 351.

³ National Intelligence Council, *Global Trends: Paradox of Progress* (January 2017), p. 159.

⁴ Natalie Myers, Jeanne Roningen, Ellen Hartman, Tina Hurt, Scott Tweddale, and Patrick Edwards. *People, Infrastructure, and Conflict: Analyzing the Dynamics of Infrastructure Disruption and Community Response*, conference paper submitted to Mad Scientist Conference 2016: Strategic Security Environment in 2025 and Beyond.

⁵ Mr. Esteban Ortiz-Ospina and Mr. Max Roser, *World Population Growth*. Published online at OurWorldInData.org, retrieved from: <https://ourworldindata.org/world-population-growth/> [Online Resource], (2016).

⁶ Dr. Elizabeth Chalecki, presentation to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (8 August 2016).

⁷ Mr. Colin Wood, *The Human Domain and the Future of Army Warfare: Present as Prelude to 2050*, conference paper submitted to Mad Scientist Conference 2016: Strategic Security Environment in 2025 and Beyond.

⁸ CSA SSG Cohort IV, *The Character of Warfare 2030 to 2050: Technological Change, the International System, and the State*, (12 July 2016).

⁹ Wood, *ibid*.

¹⁰ Africa’s population has risen; Europe’s has declined, as has East Asia’s, but at a lower rate. North American, European and Asian population age averages have increased; Africa stays young. The most significant disruption in demographics is the rise of India as the world’s largest nation, surpassing China in 2025 and translating demographic strength into economic, military, and geopolitical strength.

¹¹ Dr. Jonathan Moyer, *Global Interdependence and Trend Analysis*, conference paper submitted to Mad Scientist Conference 2016: Strategic Security Environment in 2025 and Beyond.

¹² Moyer, *ibid*.

¹³ National Intelligence Council, *Global Trends: Paradox of Progress* (January 2017), p. 163-164.

¹⁴ Ms. Kimberly Amerson and Dr. Spencer B. Meredith III, *The Future Operating Environment 2050: Chaos, Complexity and Competition*, conference paper submitted to Mad Scientist Conference 2016: Strategic Security Environment in 2025 and Beyond.

¹⁵ CSA SSG Cohort IV, *ibid*.

¹⁶ CSA SSG Cohort IV, *ibid*.

¹⁷ Amerson & Meredith, *ibid*.

¹⁸ Moreno, *ibid*.

¹⁹ Wood, *ibid*.

²⁰ Paul Horn, *The Future of Information*, presentation to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (8 August 2016).

²¹ Amerson & Meredith, *ibid*.

²² Bruce Schneier, “Botnet of Things,” *MIT Technology Review: 2017 Breakthrough Technologies* (February 2017). Professor Jonathan Moreno, *Mind Wars: Brain Science and the Military in the 21st Century*, presentation to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (8 August 2016).

²⁴ Dr. Baruch Fischhoff, *Decision Science*, presentation to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (8 August 2016).

²⁵ Peter Singer, remarks to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (9 August 2016).

²⁶ Over this time, the U.S. share of the global economy dropped from 16% to 12% percent with China replacing it as the world’s largest economy by 2030, and rising to account for as much as 20% of the global economy by 2050. Moreover, India has surpassed the United States as the second largest economy in the world.

²⁷ The “E-7” include China, India, Indonesia, Brazil, Russia, Mexico and Turkey, Price Waterhouse Cooper, *ibid*, p. 4.

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- ²⁸ Moyer, *ibid*.
- ²⁹ Moyer, *ibid*.
- ³⁰ Wood, *ibid*.
- ³¹ Sherree DeCovny, "Are Bitcoin and Blockchain Technology the Future?" *CFA Institute*, (6 January 2016)
- ³² Wood, *ibid*.
- ³³ Singer, *ibid*.
- ³⁴ CSA SSG Cohort IV, *ibid*.
- ³⁵ Independent space launch capabilities even extend to regional powers such as Iran.
- ³⁶ CSA SSG Cohort IV, *ibid*.
- ³⁷ Dr. Jason Augustyn, *Through a 4D Printer, Darkly: Science, Technology, and the Strategic Security Environment*, presentation to the Mad Scientist Conference 2016: The Strategic Security Environment in 2025 and Beyond, (8 August 2016).
- ³⁸ See the National Intelligence Council's *Global Trends: Paradox of Progress* (January 2017), p. 215. *Global Trends* refers to emerging conflicts as diffuse and diverse. Diffuse because of the existence of more actors with varied interests. Diverse because the means of conflict will vary across a wider spectrum of tools (cyber, space, advanced conventional weapons, WMD economic coercion, information warfare), and occur in multiple domains.
- ³⁹ Testimony of James P. Thomas before the Senate Armed Services Committee, *Reshaping the U.S. Military* (16 February, 2016).
- ⁴⁰ Dr. Charles Krauthammer, "The Unipolar Moment," *Foreign Affairs*, (1991).
- ⁴¹ Price Waterhouse Cooper, *The Long View: How will the Global Economic Order Change by 2050?* (February 2017), p. 4.
- ⁴² Amerson & Meredith, *ibid*.
- ⁴³ CSA SSG Cohort IV, *ibid*.
- ⁴⁴ Bruce Nussbaum, "Peak Globalization," *Harvard Business Review*, (20 December, 2010).
- ⁴⁵ Wood, *ibid*.
- ⁴⁶ CSA SSG Cohort IV, *ibid*.
- ⁴⁷ CSA SSG Cohort IV, *ibid*.
- ⁴⁸ Moyer, *ibid*.
- ⁴⁹ CSA SSG Cohort IV, *ibid*.
- ⁵⁰ CSA SSG Cohort IV, *ibid*.
- ⁵¹ Thucydides, *ibid*.
- ⁵² Joint Staff J-7, *Joint Operating Environment 2035: The Joint Force in a Contested and Disordered World* (July 2016), p. 44.
- ⁵³ David. A. Shlapak, The RAND Corporation, "What It Takes to Win: Deterring Russian Aggression in the Baltic States," *Testimony Before the Committee on Armed Services, Subcommittee on Tactical Land and Air Forces, United States House of Representatives*, (1 March 2017).
- ⁵⁴ Armies will face one another with fully modernized capabilities, such as robotic systems in all domains, tactical-through-strategic cyber weaponry, broadband electronic warfare capabilities, laser and other directed energy systems, massed, precision artillery, and long range missile systems, including hypersonic vehicles and an array of more conventional cruise and ballistic missile technologies. All forces can field improved armor and mechanized capabilities high levels of tactical mobility, protection, firepower, and situational awareness. Many nations locate their offensive firepower at home, under the protection of defensive systems and a nuclear umbrella.
- ⁵⁵ Shawn Brimley, Center for a New American Security, *While We Still Can: Arresting the Erosion of America's Military Edge*, (17 December 2015).
- ⁵⁶ Mr. Bryan Clark, *Statement Before the Senate Armed Services Committee on Reshaping the Military*, (16 February 2017).
- ⁵⁷ For the risk to great powers that choose to eschew cluster munitions, see the Mr. David Johnson and Mr. Ryan Boon, Center for Strategic and Budgetary Assessments Research Brief, "Improved Conventional Munitions Policy" (7 March 2017).
- ⁵⁸ Singer, *ibid*.
- ⁵⁹ Mr. Mark Gunzinger and Mr. Brian Clark, Center for Strategic and Budgetary Assessments, *Winning the Salvo Competition: Rebalancing America's Air and Missile Defenses*, (20 May 2016).

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- ⁶⁰ Mr. James Thomas, *Testimony Before the Senate Armed Services Committee on Reshaping the U.S. Military* (16 February 2017).
- ⁶¹ T.X. Hammes, "The Future of Conflict," in R.D. Hooker Jr. (Ed), National Defense University, *Charting a Course: Strategic Choices for a New Administration*, (December 2016).
- ⁶² Mr. George Galdorisi, *Designing Autonomous Systems for Warfighters: Keeping Humans in the Loop*, conference paper submitted to Mad Scientist Conference 2016: Strategic Security Environment in 2025 and Beyond.
- ⁶³ Singer, *ibid*.
- ⁶⁴ Dr. Andrew Krepinevich, Center for Strategic and Budgetary Assessments, *Preserving the Balance: A U.S. Eurasia Defense Strategy*, (January 2017).
- ⁶⁵ Evan Braden Montgomery, Center for Strategic and Budgetary Assessments, *Reinforcing the Front Line: U.S. Defense Strategy and the Rise of China* (2017), p ii.
- ⁶⁶ National Intelligence Council, *Global Trends: Paradox of Progress* (January 2017), p. 7
- ⁶⁷ Army TRADOC G2, *Mad Scientist 2016: The 2050 Cyber Army*, (7 November 2016), p. 36.
- ⁶⁸ Mr. Paul Tompkins and Mr. Robert Leonhard, "The Science of Resistance," *Small Wars Journal* (24 February 2017).
- ⁶⁹ Mr. David Goldman, "The Digital Age Produces Binary Outcomes," *American Affairs*, (28 February 2017).
- ⁷⁰ Ms. Nanette Byrnes, "Making Innovation," *MIT Technology Review* (16 September 2014).
- ⁷¹ CSA SSG Cohort IV, *ibid*.
- ⁷² Elsa B. Kania, "From the Third U.S. Offset to China's First Offset: The Revolutionary Potential of Quantum Technologies." 6 April 2017, The Strategy Bridge: https://thestrategybridge.org/the-bridge/2017/4/6/from-the-third-us-offset-to-chinas-first-offset?utm_source=The+Bridge&utm_campaign=2ed27fd9cc-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_bcf191ca0f-2ed27fd9cc-296376089
- ⁷³ Mr. Eric Lindsey, Center for Strategic and Budgetary Assessments, *Beyond Coast Artillery: Cross-Domain Denial and the Army*, (15 October, 2014).
- ⁷⁴ GEN Mark Milley, Address to the Eisenhower Luncheon, AUSA Annual Conference 2016.