Introduction

This article discusses plausible possibilities of what the future operational environment could look like for the U.S. Army in 2050. It is a running baseline that provides a systematic/analytical framework for follow-on analysis. It assumes that the future operational environment will be a definable state by 2050 and that the state will not be in a period of transition. It is intended to be the basis for Army deliberation and decision making about concepts, capabilities, force design, and science and technology investments. The goal is to aid creative thinking about "the realm of the possible" and to generate topics for follow-on rigorous intelligence analysis based on Army modernization priorities.

Using the first two steps of the intelligence preparation of the battlefield process—to define the environment and to describe the effects of that environment on operations—we created four alternative futures that will underpin future concepts, and we developed an analysis of sociological, technological, environmental, economic, and political trends. The intent is to focus concept development to generate Army strategies designed to secure future readiness. By anticipating the future, the Army will gain time to prepare and posture to adapt to change.

Structural Trends

Structural trends, both global and defense, are variables in a future landscape. Global trends that affect the shaping of the proposed four futures are—

- Global environmental change.
- Shifting energy markets.
- Enhanced and novel infectious diseases.
- Demographic changes.
- Challenges to domestic governance and legitimacy.
- Non-state actors.
- Defense developments.

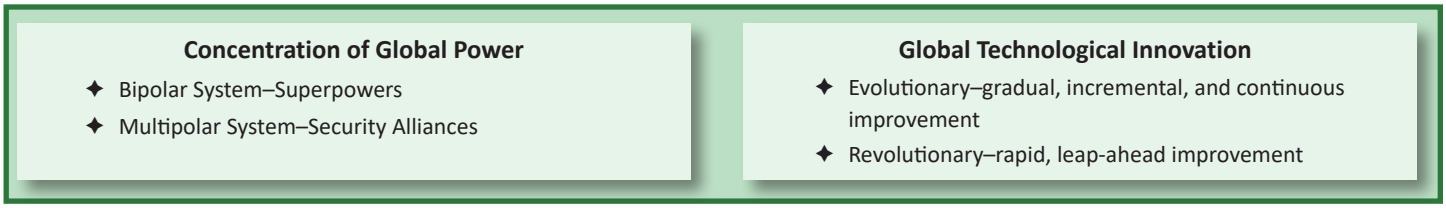
Defense trends include—

- Artificial intelligence.
- Additive manufacturing.
- Nanotechnology.
- Advanced biotechnology tools.
- Leaps in energy storage and performance.

Key Factor 1: Concentration of Global Power

The four future alternative scenarios are framed by two interdependent key factors, the first of which is the concentration of global power.

Bipolar System. In this type of world order, the majority of global diplomatic, informational, military, economic, and cultural influence is held between two states. Relations between the two "superpowers" might range from being intensely competitive to cooperative, or be somewhere in between (détente). Although parity and potential economic interdependencies would lower the risk of large-scale conflict between the two states, protracted zero-sum competition would be very likely.



Factors Influencing Alternative Futures

Threats in this future would also emerge from second-tier states and regional powers. These states may pursue their own interests by allying with one of the superpowers or forming coalitions within themselves. Regional rivalries among competing states could draw the United States into localized disputes, especially if they threaten U.S. access to resources.

Multipolar System. Alternatively, the concentration of global power may be more widely distributed across three or more actors, including non-state actors. Multipolar systems are more likely to result in the formation of security alliances: the absence of outsized diplomatic and military "checking" influence of hegemons may raise mutual fears among near-peer competitors and, therefore, preemptive coalition building.

Key Factor 2: Global Technological Innovation

The second interdependent key variable that frames the four future scenarios is global technological innovation.

Technology advancements and the diffusion of that technology will play a crucial role in shaping future competition and conflict. Because breakthroughs remain unpredictable and nonlinear, the future state of technology will remain uncertain. Our alternative futures consider two broad trajectories—"evolutionary" and "revolutionary" technological innovation. Most innovations are considered *evolutionary*, consisting of gradual, incremental, and continuous improvements to existing concepts and systems. *Revolutionary* innovations, on the other hand, result in rapid, leap-ahead improvements to existing concepts and systems, or even completely new ways of solving problems, potentially transforming markets and economic activity.

Public-Private Incentives. Technological trends largely depend on the interaction of global public and private investments in basic and applied research. Innovation trends will track public and private incentives to invest in more predictable and incremental improvements to existing technologies to solve current and emerging problems rather than more unpredictable, risky, leap-ahead technologies. Some technologies envisioned for the future, even if successfully demonstrated in a laboratory or by prototype, may not be cost-effective to scale.

Excludability and Diffusion. Many investment decisions hinge largely on the "excludability" of innovations, i.e., whether conditions limit knowledge diffusion and confer first-mover advantages. Under such scenarios, developers enjoy monopolies, ideally for periods of time sufficient to cover investment costs. Military research and development programs may be a source of such innovations. These programs may be exceedingly expensive for commercial investment or highly complex relative to commercial applications—especially if necessary components or data are unavailable on commercial markets—and will thereby preclude emulation.

If, instead, innovations are diffuse, then investments in leap-ahead technologies and systems will be discouraged by a second-mover advantage in which competitors can avoid incurring sunk research and development costs. This kind of diffusion can occur because of increasingly sophisticated communications technologies and dense information networks, widespread commitments to open-source development, plausible reverse engineering and mimicry, and economic and intellectual espionage and theft. It can also occur in situations in which breakthroughs have significant profit potential and are rapidly commercialized.

Adoption Capacity. The relative influence of technological inventions and innovations is limited by the state's educational system, the industrial base available to serialize production, and the military's adoption and use.

The Alternative Futures

The aforementioned framework resulted in four distinct alternative futures:

(1) a bipolar system with revolutionary technological innovation,

(2) a multipolar system with revolutionary technological innovation,

(3) a bipolar system with evolutionary technological innovation, and

(4) a multipolar system with evolutionary technological innovation.

In this article's descriptions, attention is devoted primarily to the consequential futures of greatest concern to the Army that would consume the most resources and without a guaranteed positive outcome.

Alternative Future Number 1: The New Cold War

Alternative Future Number 1: The New Cold War. In this potential future, the United States and China compete to achieve global supremacy. In doing so, competition will dominate the United States–China relationship. Superpower competition will drive global trade and diplomacy. Competition will not necessarily be ideologically based but rather will focus on a systemic struggle between liberal democracies versus authoritarian, centralized regimes. An intense focus will be on access to the markets, commodities, and global commons. In this future, the United States and China may cooperate on less contentious issues like counter-piracy, disaster relief, and terrorism.

Global economics will be heavily influenced not only by traditional factors such as trade agreements and technology transfer but also by digital trends in cryptocurrency. To enable its global economic aspirations, China invests heavily in disruptive technologies. China uses these technologies to gain economic and military advantages over the United States in sectors like space, biotechnology, and quantum computing. Access to and control of information will continue to be a strategic commodity. Adversaries will use data analytics to manipulate personal information to target individuals in the information domain. Disinformation campaigns will favor the offense and the actor who best dominates and controls the narrative.

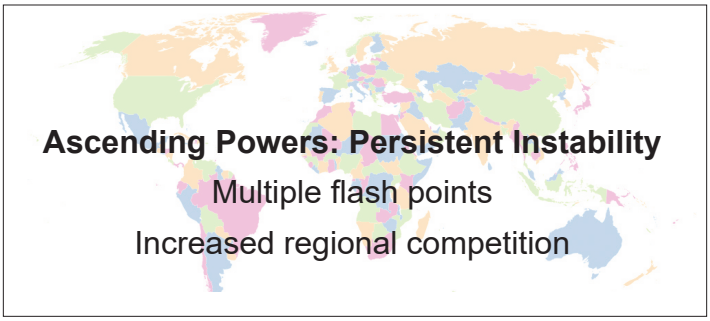
Since advanced weapons and economic interdependencies will likely deter the two superpowers from engaging in large-scale conventional warfare, the powers will engage in a series of proxy wars around the world. Conflict and competition will likely occur in dense urban environments that will involve elements of the U.S. Army.

China continues its military growth and modernization efforts by developing and fielding advanced technologies. The People's Liberation Army, the regular armed forces of the People's Republic of China, continues to exploit the space and cyberspace domains and is increasingly proficient in semi-independent maneuver, extended expeditionary capabilities, hypersonic and supersonic missiles, advanced long-range precision fires, and directed energy weapons. The People's Liberation Army's Strategic Support Force has the capabilities to target U.S. logistics systems and installations and impede U.S. naval and expeditionary maneuver by cyber-directing autonomous merchant traffic into congested sea lines of communication and port facilities. To erode any United States-backed defense coalition, China is able to use economic warfare instruments to drive a wedge through United States alliances by threatening American partners with economic isolation if they do not agree to favorable security pacts and trade agreements with Beijing instead.

Total war between the superpowers is not likely but is possible. If the United States secures a limited capability that China does not have, Beijing may feel compelled to act before the United States has a chance to field the system. Alternatively, if China develops a niche capability, it may also feel bound to act first to maintain its advantage. Total war could also result from misperceptions or an unexpected escalation of hostilities.

In this future, threat projection will be geographically predictable and centrally focused on one peer adversary. The Army must consider how threats could manifest in a number of ways. The introduction of nuclear-capable hypersonic/supersonic missiles launched from various platforms truncates response time and, coupled with ambiguity of origin, increases the probability of miscalculation. Digital maneuver capability (cyberspace defense/attack, virtual power projection, and digital information operations), increased robotics and autonomy, and attacks on critical infrastructure and sustainment systems are increasingly important to achieve the advantage in military operations. Protection capabilities will require the adoption of system-level defense strategies like multidimensional protection, the inclusion of critical civilian infrastructure, and the reemergence of capabilities such as biodefense (pandemic response), economic warfare, and information control.

Alternative Future Number 2: Ascending Powers. This future is marked by persistent instability and conflict with "revolutionary" technological innovation. The transition to this world is marked by considerable unrest, which is exacerbated by the threat of highly disruptive, revolutionary military technologies. The long-running political and economic struggles between the United States and China now result in economic stagnation, while emerging powers leverage decades of liberal economic order to consolidate wealth critical to their military power. Economically, this future experiences an economic rebalancing that shifts power away from a Western rules-based global banking environment toward systems dependent on foreign currencies and



Alternative Future Number 2: Ascending Powers

cryptocurrencies. In this future, regional powers will check each other to maintain a relative balance and prevent the rise of any one power. Several actors (for example, United States, China, Russia, India, and Europe) constantly face "balancing" forces from one another and from other aspirational powers. In doing so, actors expend valuable resources in a protracted struggle for dominance and advantage.

A number of states expend valuable resources, including military power, in a protracted struggle to gain advantage. In the absence of a global superpower to mitigate conflict escalation, competing security coalitions and the race for resources create persistent levels of conflict between states. At the same time, the disintegration of power within states fuels social unrest and insurgencies, which are increasingly lethal as non-state actors secure advanced weapons systems and external powers entangle themselves in local wars as a way to challenge rivals.

Diplomacy in this alternative future is no longer dominated by the interests of two global superpowers, transforming instead into a highly dynamic—and, at times, brittle—system conforming to the interests of many more peer and near-peer states. Moreover, because technological innovations emerge from multiple actors in this alternative future—not from only two superpowers—states will use technology diffusion to serve their interests, leveraging highly valuable, exclusive revolutionary technologies as diplomatic centerpieces.

In this alternative future, threats are geographically unpredictable, occur across multiple domains, and are dispersed widely among numerous adversaries with varying degrees of temporary overmatch and intentions. The U.S. Army is forced to engage in many types of conflict, perhaps simultaneously, in which Soldiers face a range of highly capable adversaries—from conventional forces to insurgents, as well as transnational criminal organizations, mercenary armies, and proxy forces. Due to heightened international competition and the primacy of security coalitions, the U.S. Army acts as a secondary player in many conflicts, with allies taking the lead on grounds of national interests or niche technological leadership. Alliances are critical to shore up U.S. defense and strike capability, deter economic aggression, and mitigate distributed information warfare campaigns.

Alternative Future Number 3: Stable Competition. In many ways, this alternative future resembles the world of today. In it, enduring economic and political effects of successive global pandemics cause the United States to lose its position as the sole superpower, while China ascends to superpower status on the back of its thriving economy.

China continues to disperse its economic production activities globally to its spheres of influence, challenging United States multinational corporations. China guarantees the manufacture of military, medical, and supplies vital to national security through domestic means or from trusted bilateral partners. China continues to invest heavily in leading-edge technologies. The Communist Party places the highest priority on any investment that maintains wealth generation critical to its legitimacy.

The pace of technological advancement results in marginal change to the deployment speed and lethality of military systems, moderating fears among competitors and lowering the risk of preemptive strikes in reaction to perceived military gains. Military parity and continuing economic interdependencies between China and the United States are deterrents to large-scale conventional warfare. In the unlikely event of large-scale conflict, however, Chinese forces would rely on legacy systems—perhaps employed in novel ways—or marginally disruptive technologies involving artificial intelligence and autonomy.

Alternative Future Number 3: Stable Competition

China attempts to conduct covert economic and financial warfare against the United States—including artificial intelligence-enabled malware and ransomware attacks against commercial, defense-logistics, public-infrastructure, and installation targets—in order to undermine United States military capability and achieve marginal economic advantages. However, the evolutionary pace of technological change allows sufficient time for potential targets to develop reliable countermeasures, undermining China's ability to attack in non-attributable ways.

In an emerging bipolar world, lower-tier states pursue bilateral relationships and economic and security blocs increasingly aligned to Chinese economic, diplomatic, and military interests, as well as parochial pacts with whoever best affords security and economic opportunities. China plays a more active role in leading the international order, partly through its participation in key international institutions. It seeks to lead on emerging technological standards and agreements but otherwise continues to weaken international norms of human rights and political freedoms, transparency, and accountability. Many of China's international relationships will be transactional in nature.

In this alternative future, the United States military must prepare to confront a familiar array of challenges such as Chinese military modernization and expeditionary operations, increased Russian proxy warfare and land-grabs in Europe and Central Asia, Iranian and North Korean nuclear development, and the ever-present threat of insurgency and terrorism. It will do so within a system of degraded alliances.

Alternative Future Number 4: Clashing Coalitions. In this alternative future—a multipolar system with an "evolutionary" rate of technological innovation—rising and declining states compete with one another, regional rivals, and even non-state actors for resources and global influence. A protracted era of globalization—including free trade, investment, and labor-flow regimes—has been a central feature of the leveling dynamic, producing several regional hegemons. Any moves toward protectionism or bilateral or regional trade exclusivity will undermine economic stability; therefore, such behavior is rare. Partial defections from the current globalized economic order occur in limited situations in which ascending regional powers challenge the standing of their respective regional hegemons. Because ascending powers are incapable of acquiring truly provocative "leap-ahead" capabilities, this kind of event is uncommon.

In order to maintain wealth generation critical to military power, all regional hegemons invest heavily in domestic infrastructure and human capital. Furthermore, these states continue to support the private engines of their economies, facilitating the dispersal of economic production activities globally. Multinational corporations wield significant political-economic influence. In this environment, first-mover advantages are marginal and fleeting, except where actors are able to maintain periods of excludability around highly marketable marginal innovations or novel convergences of existing technologies.

The evolutionary pace of technological innovation does not produce large military disparities among competitors, or the corresponding atmospheres of uncertainty and fear.

Alternative Future Number 4: Clashing Coalitions

Lower-tier states can band together to force the negotiation of institutions over which regional hegemons attempt to maintain disproportionate sway. Acute diplomatic disputes and sporadic military conflict may occur over access to critical, ever-dwindling natural resources. Furthermore, there is a heightened risk that states will misinterpret the increasingly complex network of mutual "red lines," or the extent to which a competitor will go to defend their interests.

In a world of evolutionary technological innovation, strategies of discreet, marginal improvements to one's relative economic and military standing—including through impeding competitors' progress—are particularly effective. Many regional hegemons conduct covert economic and financial warfare against adversaries' commercial, defense-logistics, public-infrastructure, and installation targets.

As in the multipolar alternative future with "revolutionary" technological innovations, threats in this world are geographically unpredictable, occur across multiple domains, and are dispersed widely among numerous adversaries with varying intentions. The U.S. Army has to engage in many types of conflict, perhaps simultaneously, in which its Soldiers face a range of highly capable adversaries.

Conclusion

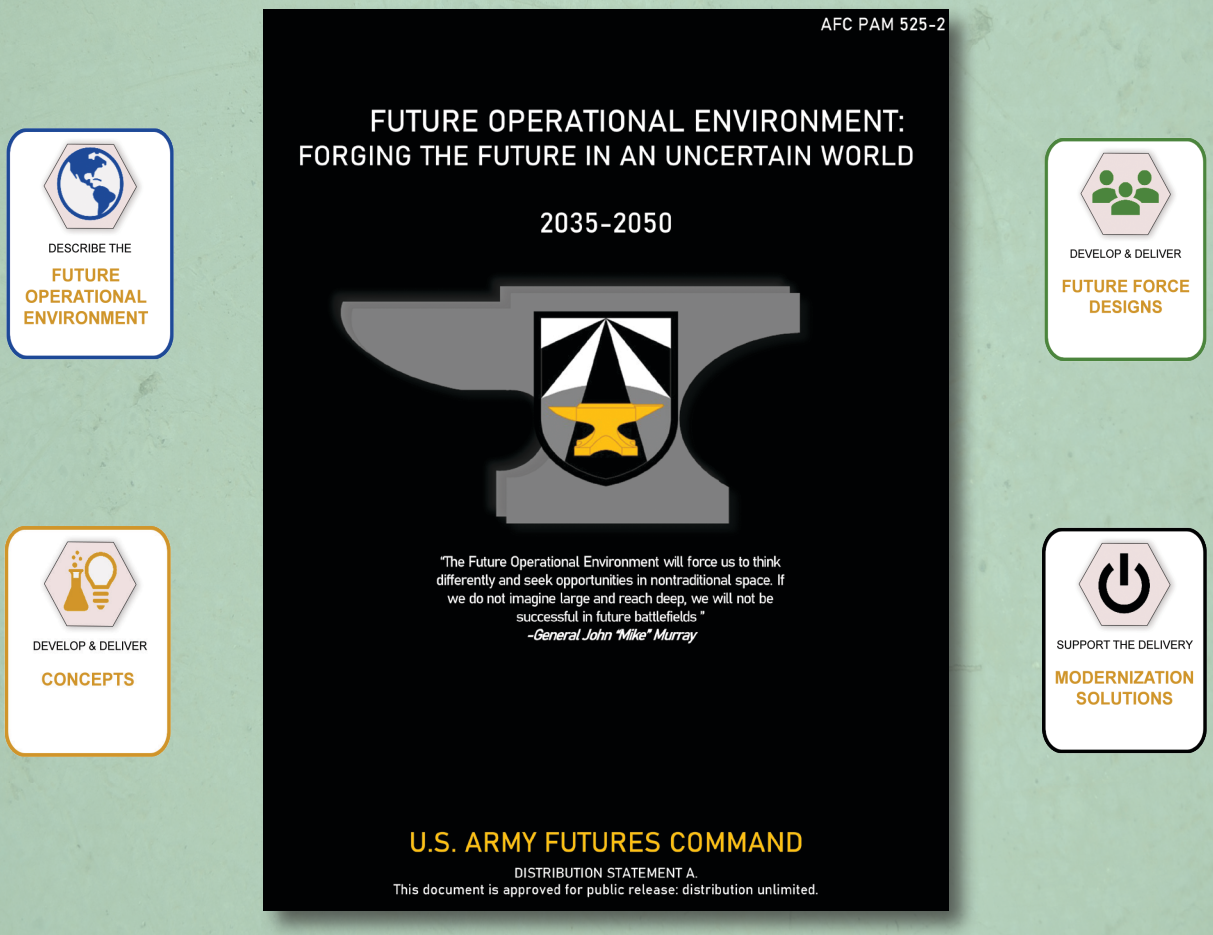
These alternative futures are neither definitive nor all-inclusive. Regardless of whether the United States finds itself in a bipolar system or a multipolar system, the trends suggest that the Army should prepare itself for a range of threats in a world where the United States is no longer the sole superpower.

The intent of this article was to generate critical discourse among Army and Department of Defense senior leaders about the future, implications for the Army, and requisite investments in concepts, technology, materiel, and training. As a next step, a future operational environment running-estimate will explore various key topics in order to challenge and enrich the descriptions in this article. The information presented here should be taken as the first word, not the last, in preparing to think about how to fight, win, and forge the future.

The Future Operational Environment Directorate, Futures and Concepts Center, assesses the threat and future operational environment. It also develops future concepts, requirements, and an integrated modernization pathway to increase lethality and overmatch to enable Soldiers and units to compete—and, if necessary—deploy, fight, and win future wars.

The Directorate of Intelligence and Security, U.S. Army Futures Command, orchestrates the evaluation and assessment of current, emerging, and future threats and the development of the operational environment; synchronizes multi-disciplined technology protection activities; and conducts intelligence and requirements integration for the Future Force Modernization Enterprise to build a multi-domain operations (MDO)-capable force by 2028 and an MDO-ready force by 2035.

Check out the Army Futures Command's new AFC Pamphlet 525-2, *Future Operational Environment: Forging the Future in an Uncertain World 2035-2050!*



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