The Character of Warfare 2030 to 2050: Technological Change, the International System, and the State

Cohort IV
Foreword by Benjamin Jensen, Ph.D. and John T. Watts
Character of the Future Operational Environment, 2030 - 2050

1. Hypothesis
   The interaction of a slowing rate of technological invention and its ensuing diffusion, an increasingly competitive multipolar international system, and weakening states will likely lead to increased confrontations between the United States and regional powers as well as more localized unrest and conflict.

   - Competitors catch up before U.S. leaps ahead
   - The international system – less international, more regional
   - Easy to organize; unrest will be cheap

2. Concept
   Technology
   Rate of Invention
   (High to Low)

   Governance
   State Strength
   (Fragile to Stable)

   International System
   Degree of Order
   (Integrated/Cooperative to Degraded/Competitive)

   A connected world puts a premium on the fight for information and denying adversaries the ability to mass effects. Actors compel one another indirectly and use proxies as fixing forces all underneath the threat of strategic escalation involving cyber, ballistic missiles, and nuclear weapons.

   - What can be identified can be disrupted
   - Interdependent regional powers fight in gray zones
   - Find new ways of combining existing technology

4. Method
   4 Lenses: US, Allies, Private Sector, Competitors
   Crowsource the Future: >8,000 observations
   Trend Analysis: convergence, divergence
   Hypotheses: translate trends into forecasts
   I&W measure and refine forecasts annually
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Every major defense study has a story. There is a logic linking together different professionals struggling to make sense of the changing world around them. For General Depuy’s staff seeking to guide the U.S. Army after the Vietnam War it was the reality of a new battlefield lethality on display in the 1973 Yom Kippur War. For Generals Sullivan and Dubik, the information age called for a new approach to combined arms maneuver. War changes with society and creates a new context for military professionals.

The story of this study began in 2015, when General Mark Milley, after his confirmation as the 39th Chief of Staff of the Army, tasked his Strategic Studies Group (SSG) – now known as the Army Future Studies Group - to visualize and describe the future character of war between 2030 and 2050. The effort was deliberately kept separate from formal Army studies conducted by the U.S. Army Training and Doctrine Command, G2 and the larger Intelligence Community, as well as think tanks supporting senior leaders as a means of soliciting independent estimates. Knowing that senior leaders wanted a range of different assessments in place of consensus, the study embraced a dialectical logic, exploring how the expectations of different groups converged and diverged from one another.

More importantly, the study, which is not an official Army position, committed to the idea of the future as a still unfolding story. Rather than make a single, definitive forecast, the authors conceptualized it as a running estimate of the future. That is, the study was a living document capturing a series of bets about the future so that senior leaders could respond to changes in the character of competition, confrontation, and conflict. The original study group envisioned an open update process that drew on both military fellows and external academics to challenge the original estimate and assess how changing conditions altered prevailing expectations about the future.

What Did the Study Get Right?

The central argument of the 2015 study was that the future would be defined by an increasingly competitive, multipolar system where weakened states simultaneously managed localized unrest and competed with other regional powers over...
spheres of influence. In some ways, that world didn’t wait until 2030 to emerge. The standoff between Saudi Arabia and Iran in the Middle East amidst corruption purges and proxy wars appears to be a harbinger of the future. The 2015 study also predicted that these regional confrontations, which the United States by virtue of its treaty system would be drawn into, would see significant increases in military capabilities. Put simply, multiple actors would catch up to the United States fragile monopoly on precision warfare before America leaped ahead. In this world, defense would be ascendent increasing the costs of conflict and forcing great powers, especially where they are hyper connected by global supply chains, to compete in gray zone conflicts short of war. One needs look no further than Russia. From their investments in enterprises across Europe and America despite sanctions, often revealed in leaks about offshore banking, to increasing activities challenging NATO across its northern, eastern, and southern flanks, Russia is locked in gray zone competition with the West.

Where the 2015 study was especially prescient was foreseeing competition in this world as a fight for information and legitimacy. In an unclassified but limited distribution annex, the study team highlighted how states like Russia would undermine rival state legitimacy from within using political warfare online combining cyber effects and propaganda. The purpose of these new campaigns would be to limit U.S. resolve and power projection. One needs look no further than the Russian efforts to target elections not just in the United States, but in France as well to see this dynamic.

**What Did the Study Get Wrong?**

While the 2015 study did capture many emerging trends, it tended to miss some important features confronting current decision makers. The study was two-years off in assessing the North Korea’s missile advancements and provocation timeline. While the study did highlight how rogue states like North Korea would use their nuclear and cyber capabilities to coerce the international community, it did not capture just how immediate this threat was.

Second, the study discounted nationalism. While the study did envision anti-globalization movements challenging governance structures, it underestimated the extent to which these would take nationalist and often outright racist, anti-immigrant forms in developed societies. In a globalized world, the state remains a rallying cry for groups that see themselves, right or wrong, as disenfranchised. From the comingling of nationalist and Islamic sentiment in important allies like
Turkey, to the re-emergence of isolationism in the United States there is a growing backlash to a connected world.

Last, the most debated conclusion from the original study is the claim that there is an almost even chance that the rate of invention is slowing. The original claim has yet to be disproved systematically. Yet, it tends to provoke a reaction in audiences. We all tend to think we live in a world characterized by accelerating technology and its diffusion, from drones to social media, that change our daily lives in tangible ways. What the study authors were after though was strategic pause and skepticism about the degree to which the technological advances ordering our world were new. Most of the technology we uphold as ‘new’ is the result of basic research investments over ten-years old. Innovation therefore, as the combination of existing technologies in novel ways, is accelerating but fundamentally new inventions are not emerging at the rate most futures studies expect them to. What is almost certain is that the U.S. military will make the greatest return on its modernization investments from capitalizing on adapting existing technology (i.e., innovation) than pursuing unproven science and technology in hopes of discovering the next gun powder, radar, or stealth (i.e., invention).

**What did the Updates Reveal?**

In 2016, a new cohort of fellows built on the original study through exploring emerging powers, shifts in the international system, and how trends in the U.S. domestic arena could alter American power and interests over the next twenty years. First, the group sent fellows to India to capture how dynamic growth and geopolitical fault lines intersect India’s unique domestic political environment to alter the character of competition, confrontation, and conflict. Second, the team explored how increasing polarization could affect grand strategy and how the U.S. generates and projects combat power in the future. Third, the group conducted multiple wargames based on scenarios derived from the original study and subsequent trend analysis by partners in the Pardee Center for International Futures. Last, members of the group sought to cultivate a marketplace of ideas by publishing a column in one of the leading defense commentary outlets, War on the Rocks, entitled “Next War.” These short pieces explored important topics that emerged as fellows updated the 2015 study including the integration of narrow artificial intelligence into the Army, the intersection of gray zone competition and major theater war, and autonomous systems.

In addition to military fellows, the study group offered the unclassified study to students at Columbia University, School of International and Public Affairs and
American University, School of International Service (SIS). These student teams concluded:

- Climate change is very likely to alter the future character of competition, confrontation, and conflict beyond what the original study forecast leading to superstorms, localized unrest, and challenges to governance.

- Megacities and dense urban areas are not correlated with increased interstate or intrastate violence and may actually order social relations while shifting patterns of political violence to protests, coups, and terrorism.

- Gender norms almost certainly matter and how societies think about identity could alter long-term economic and political trends, especially in the Middle East and Africa.

- The future will not be evenly distributed across regions. Led by Dr. Paul Gelpi and multiple research teams in the Planning, Forecasting and Decision-Making seminar at SIS, students teams explored regional scenarios and concluded that:

  - Changing energy markets alongside the proliferation of multiple technologies will likely challenge Middle Eastern states.

  - Regional Cold Wars would become the norm in South and East Asia.

  - Russia will remain a declining power that challenges the United States and NATO.

  - A new breed of transnational criminal organization (TCO) would thrive across Africa as state and non-state actors compete for the continents mineral wealth.

**What is on the Horizon?**

The group that wrote the 2015 study and conducted subsequent research efforts became the Army Future Studies Group in 2017. In this capacity, the military fellows will continue updating the running estimate of the future and use the resulting inferences to design scenarios and wargame-based experiments that help senior military leaders visualize and describe the changing character of competition, confrontation, and conflict. The resulting working papers will complement, not replace, the multiple formal efforts in the U.S. Army and broader futures communi-
Futures work is complex, challenging and speculative at the best of times. The best hedge against an unpredictable future is the nurturing of multiple, diverse and analytically robust perspectives about all facets of the possible future environment. This includes analysis and forecasting of established trendlines as well as consideration of unlikely but plausible, and disproportionately disruptive emergent issues. Moreover, it requires ongoing experimentation in futures approaches and methodologies and ensuring a platform for diverse, non-traditional and divergent viewpoints. Achieving this requires a network of partners, both within the military and the wider community that includes industry, academia and other practitioners. The Army Futures Study Group will continue to play a key role in this process, and we at the Atlantic Council look forward to continuing to support the process by providing a forum for the development of diverse insights, foresight and strategy development.

November 22, 2017
Benjamin Jensen, Ph.D.
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Executive Summary

In 2030, slowing technological invention, a degrading international system, and weakened states will likely create an operational environment that on the surface appears similar to that of 2016. The character of warfare will evolve, but slowly and unevenly. Game-changing technology will be slower to materialize than promised, which will give regional competitors a chance to catch up to U.S. military capabilities. Uneven economic growth, localized resource insecurity, increased mass migration, networks of activists, and violent non-state actors will challenge states with a mix of unrest, targeted violence, and cyber-attacks. In this world:

- **There is a nearly even chance that the rate of technological invention will slow**
- **A competitive multipolar system will likely increase strategic competition**
- **Supra- and sub-state actors will very likely continue to challenge state autonomy and authority**
- **Both interstate and intrastate conflicts are likely to increase**

Developed from an analysis of more than 1,000 sources by the Chief of Staff of the Army’s Strategic Studies Group, the attached report describes the likely operational environment in the 2030 to 2050 time frame through a mix of Military Decision-Making Process (MDMP) and crowd-sourcing techniques. The result is a portrait of the character of warfare as an interaction of the rate of technological invention, that is, how fast technology advances; the composition of the international system; and the state’s governance capacity.

This study takes a cautious view of technological promises circulating in 2016. Sensor ubiquity, massive digital data production, improvements in data analysis, and declines in the cost of these capabilities are nearly sure bets, and they will impact military forces’ ability to avoid detection and destruction by way of precision strikes, and how those forces see the battlefield and execute mission command. Less certain are the future ability to rely on ground and space-based information networks, the transition of myriad military functions to artificial intelligence-enabled autonomous systems, widespread reliance on additive manufac-
turing to ease the logistical requirements of power projection, and the potential for human enhancement.

The study agrees with most major futures studies that China will have the potential to challenge today’s international system. The report concludes, however, that while China’s capabilities will almost certainly improve to the point at which it can deny U.S. freedom of action in its near abroad, China should not reflexively be viewed as a threat to the international system. China’s elites value domestic stability over all other goals, and continued economic growth is their strategy to achieve this goal. While America’s military must be prepared to deal with potential Chinese military challenges, these are likely a preventable contingency.

Last, like most futures exercises since the 1970s, this study concludes that continued challenges to state authority are very likely. While the risk of a military dispute between regional powers that escalates into a larger conflict will continue to decline, the number of intrastate conflicts and gray-zone competitions will rise. States will confront unrest from above and below as networks of activists and violent non-state actors challenge their authority. Localized resource challenges, migration, inequality, and the low cost of mobilizing combatants in the information age will add fuel to this fire.
Technological Change, the International System, and the State

Chief of Staff of the Army’s Strategic Studies Group Cohort IV (2015-2016)

Respectfully submitted on behalf of the fellows of Cohort IV of the Chief of Staff of the Army’s Strategic Studies Group,

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Cohort IV and the entire Strategic Studies Group gratefully acknowledge the leadership and mentorship of its senior mentor, Lieutenant General Charles C. Cleveland, U.S. Army Retired.
A View of the Future: March 31, 2033

The 43rd Chief of Staff of the Army (CSA) sets off on a trip to Dhaka, Bangladesh, from her home at Ft. Myer. The Chief’s software-based assistant, Marshall, assesses the talking points that the staff prepared by comparing them to trending terms. As the driverless car makes its way through beltway traffic, the CSA reviews Early Bird headlines:

- Firms Linked to Chinese Government Open New Logistics Hub in Central Asia
- PLA Conducts Live Fire Exercise with Hypersonic Missile Supporting Ground Forces
- Despite Recent Thaw, Cyber-Attacks Traced to Russian Criminal Groups Target Bank Accounts of North Atlantic Council Members
- Another Superstorm Set to Strike Caribbean

The Chief asks Marshall to generate a staff estimate on how the storm will affect Army advisors attached to a Justice Department mission working with local police in crime-ridden Kingston as well as Corps of Engineers assets in Puerto Rico assisting USAID’s climate-change hardening projects. Remembering Shakespeare’s line that the “past is prologue,” the CSA recalls her first humanitarian-assistance/disaster-relief mission and studying Russian doctrine at the Naval War College. Digging into an article, the CSA reads more about the day’s biggest news, an overnight terrorist attack in Cairo conducted with armed drones and cyber in which hacked traffic cameras created a remotely monitored surveillance network. In response, Egyptian police and military units cordoned off a 10-block area and implemented an information blackout, which quickly led to protests. Marshall mentions that the Chief has a note waiting from the Army Attaché in Cairo that provides an overview of how the attack – the second this year – links to ongoing migration in Africa and new international military support requests from Egypt for counter-unmanned aerial systems, cyber-defenses, and intelligence training.
While boarding a plane for the 13-hour flight, the Chief greets a group of congressional staffers and officers from the Army Staff who are joining her for the trip. Army Staff officers brief their recommended budget priorities for the next budget cycle, making the case for a balanced program that includes continued cyber and Big Data investments; partner-exportable dual-use anti-air, anti-sea, and ground-attack munitions; bio- and genetic weapons surveillance and defense systems; and new HA/DR prepositioned stocks. They highlight that many of these items respond to national priorities and directed contingencies, which all too frequently lack overseas contingency funding lines, thus pressuring other accounts, which are in decline. The staffers explain that while they support the Army, political realities have driven growing budget pressures to reduce the size of the force and the operating budget. A younger staffer tells the Chief, “We need you to explore adopting fully autonomous systems that lower personnel costs, lift the fog of war, and increase the speed of the kill chain.” An officer of the Army Staff pushes back, arguing that “uncertainty and the clash of wills are enduring aspects of the nature of war. While the character of warfare does appear to be changing, that rate of change is slower than we expected in the 2020s. We want to proceed incrementally, using cheaper, off-the-shelf AI and autonomous systems to enhance human judgment, not replace it.”
The Character of Warfare 2030 to 2050

Defining the Future
Operational Environment

In the world of 2030 to 2050, the combined interaction of the rate of technological invention and the extent to which it diffuses, an international system that is trending to multipolarity, and continued challenges to the state’s capacity to govern will very likely define the character of warfare.

Thesis

War is – and will remain – “an act of force to compel our enemy to do our will.” But the manner in which that will is imposed – or the character of warfare – changes with the circumstances of the era. A world composed of states typically means that at least one side of any armed conflict is a state or a state-sponsored actor. Those states, in turn, form an international system, and that system shapes how, when, where, and why those fights occur. At the same time, available technology determines the weapons with which people will fight and, in part, their ability to translate economic wealth into military power.

These three factors – technology, the international system, and the state’s capacity to govern – interact and, in turn, condition the choices available to decision makers who are engaged in strategic competition among one another other. Thus, the rate of technological invention – and, in particular, how fast artificial intelligence (AI), quantum computing, or autonomous systems emerge – will likely determine what coercive tools are available to state and non-state actors from 2030 to 2050. Similarly, the degree to which the U.S.-led international order survives

Major Global Trends:

Technology:
- Nearly even chance the rate of invention will be less than expected.
- AI is a game-changer.

International system:
- Trending toward multipolarity.
- China’s decline is a possible shock.

Governance:
- Array of actors will likely challenge sovereign authority.
- Increased inequality, migration, resource competition is likely.
challenges from emerging regional powers during that period will likely shape the type of multipolar system in which future competition and conflict occur. At the same time, international organizations, technology-enabled activists and extremists, and resource insecurities (i.e., food, water, and energy) will test the governance capacity of modern states.

This interaction of the rates at which technology changes and those changes are paired with concepts (i.e., innovation) and its subsequent diffusion throughout the globe, the composition of the international system, and the governance capacity of states is more likely to produce evolutionary rather than revolutionary change in the future operational environment. Breakthroughs cannot be predicted, and game-changing technologies tend to appear over time, and in a nonlinear fashion, as governments and companies struggle to achieve cost-effective solutions to current and emerging problems. Further institutions exist, in part, because they resist change. Thus, the norms of interaction between and among state and international institutions, non-state actors, and even individuals change slowly. For these reasons and despite continued challenges from above and below, states remain the operative political unit in the international system, as they have for more than 400 years.

The forces of continuity imply that the past will continue to be prologue. After considering the convergent and divergent trends and forecasts, the SSG deduces that the future is unlikely to look radically different from the present.

Task and Method

On September 29, 2015, the Chief of Staff of the Army tasked his Strategic Studies Group (SSG) to describe the future operational environment between the years of 2030 to 2050. To accomplish its task, the SSG employed a meta-analysis approach involving over 8,000 observations gathered from interviews and published sources that were organized in a custom database. The database enabled the team to sort records, describe trends, and draw out qualitative inferences on global trends and their military implications. For example, the percentages in this report are based on the total number of sources in the database that addressed a topic on a unique entry. The process reflected a synthesis of the MDMP – specifically, the Intelligence Preparation of the Environment – with energy-sector-style scenario-development techniques and crowd-sourcing concepts.

This report differs from major futures studies currently in circulation. As an initial matter, it factors a larger array of sources than are incorporated in most studies. Thus, many of the other studies appear to essentially adopt the National Intelli-
gence Council’s (NIC) Global Trends product. Or they are based on limited survey (less than 50) of experts.

More importantly, though, this approach factors source diversity. Based on the truism that where you sit is where you stand, this report assumes that different groups imagine different futures – an assumption missing in most long-term studies. Thus, the SSG sought to build its description of the future by “seeing” the world of 2030 to 2050 through four discrete lenses: the U.S. enterprise lens, including government, think tanks, and major academics; U.S. allies and partners in 2016; potential U.S. competitors, determined by using the “4+1” construct;3 and private-sector organizations, focusing both on technology-based companies and those firms making longer-term, capital-intensive investments. These actors have different forecasts of the future, and those different perspectives, in turn, inform those actors’ investments, which help shape the future. By analyzing where these forecasts and investments converge and diverge within and across the lenses, the SSG has developed a description of the future operational environment and the likely future character of warfare.

The strength of this approach is its systematic rigor and diversity. The limit to this approach is that given the large categories used to organize lens views, it remains a limited sample of that larger population. The research did not, for example, systematically survey youth populations who will shape the future or, for that matter, large segments of the developing world that are likely to experience population growth in 2030. Furthermore, no approach can completely remove cognitive and personal bias, or the predominance of particular viewpoints. Indeed, the planning fallacy and the hindsight bias both play roles in distorting this – and any – forecast.4

Moreover, as Colonel Summers wrote in the Astarita Report, charting a course to the future is “at best an imprecise science shaped more by perceptions of the past and present than by visions of the future.”5 Many of the database entries suffered from an apparent availability heuristic (i.e., the tendency to focus on topics with which those sources were personally acquainted to the exclusion of others), which led to the overweighting of current events, or the anchoring heuristic. Others

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**Studying the Future**

Using small groups to study the future character of warfare has a long history in the U.S. Army. In 1875, General William T. Sherman, then-Chief of Staff, dispatched Emory Upton to study force structure and training of different militaries in Europe and Asia. In 1973, General Creighton Abrams chartered a Strategic Assessment Group to determine “if there was a legitimate role for conventional strategy and the Army in the post-Vietnam world.” These two and other studies tend to highlight an important observation: the past is prologue.
demonstrated the bandwagon effect and, like other futures studies, echoed major U.S. government documents, such as the NIC’s Global Trends or the Quadrennial Defense Review. Further, it appeared that confirmation bias pervaded all sources, and some forecasts also tended to be political and are likely designed to advance preferred solutions.

Finally, although this analysis is based on the trends highlighted and the forecasts made by others, any forecast of the future, this one included, should acknowledge the uncertainty of that future. Former Secretary of Defense Robert Gates may have exaggerated when he infamously claimed that when predicting the future, “we have never once gotten it right.” But there are examples that suggest that Secretary Gates was more right than he was wrong. For instance, in its December 2000 Global Trends 2015, the National Intelligence Council candidly acknowledged that “few predicted the profound impact of the revolution in information technology.” If this major trend can be missed, others can be as well.

Despite these limitations, which plague all long-range planning and forecasting, the SSG assesses that its database and analysis, combined with four months of debate and dialogue among the team of Army officers, senior non-commissioned officers, academics, and civilians, presents a balanced view of the world of 2030 to 2050. More importantly, however, this project was designed to be continuously updated. Specifically, the Indications and Warnings identified in the report are meant to be tested as the future develops. And as new data becomes available, that data can be incorporated into the database and this report’s forecasts can be adjusted. Subsequent SSG cohorts can discern changes in the future as they occur over time, adapting this “first look” with each subsequent look of the future.

**Literature review**

The major futures studies circulating in 2016 can be generalized as proposing two types of trends: technology trends and everything else. For technology, the majority of studies foresee the emergence of advanced robotics, additive manufacturing, and autonomous systems changing the nature of economic activity and the character of warfare. These trends have the potential to produce a massive disruption in labor markets and higher levels of inequality globally. These studies also suggest that because of the proliferation of technology, major states will no longer have a monopoly on military technologies that enable persistent ISR and precision strike (e.g., like those developed in the Second Offset). By way of deduction, these studies rest on two assumptions: first, the continued reduction in the costs of both connectivity and sensors, and second, significant advances in AI and computer
processing power. All major futures studies assume these trends and envision a world that by 2030 to 2050 relies in part on at least basic AI to augment human decision making in the economic and military spheres.

Among non-technology trends, major futures studies generally present two alternative views of the world in 2030 to 2050. The first is a world in which great- and rising-power competition occurs in the midst of the emergence of the technologies highlighted above, which create massive productivity gains, an occurrence that some have termed the “Fourth Industrial Revolution.” The shift of economic power from Western nations to the global south and east creates a political transition. Ascending regional powers like China increasingly challenge a U.S.-led international order. In Europe and East Asia, demographic trends and disruptive technologies shift the guns-or-butter debate toward subsidizing aging workers whose labor has been made obsolete. At the same time, a new “Great Game” occurs in which rising powers seek a stake in resource-rich regions.

The second view is more Malthusian. Climate change pushes growing populations across borders, stresses states, and creates popular unrest. Food insecurity, water scarcity, and superstorms plague already fragile states. Political entrepreneurs – from extremists to profit-driven warlords – mobilize disaffected populations and challenge governments from below. In this world of growing scarcity, the central question becomes whether governance mechanisms are sufficient to manage the unrest.

The SSG report agrees with many of these observations, albeit with some important differences concerning the rate of technological change. The SSG’s sources saw a world defined by regional competition and a mix of economic and environmental trends that are likely to create localized unrest. Unlike other studies that stress
the increasing rate of invention – really, faster technological change – and with the exception of sources from the U.S. enterprise lens, the SSG’s conclusion suggests a slower, evolutionary future. Pure autonomy, artificial general intelligence (i.e., humanlike), and genetic engineering are all possible but will each likely take longer to emerge and to reach price points that are necessary for broad commercial diffusion and military application. Technological invention – when paired with a concept that makes such invention useful, i.e., innovation – is part of economic productivity and, consequently, economic growth. Thus unless other components of growth increase sufficiently to compensate, a slower rate of technological invention also implies slower economic growth. Together, this impacts how states manage unrest, compete with one another in a multipolar system, and deal with the private sector.
The Character of Warfare 2030 to 2050

Describing the Future Operational Environment

Technology

Chances are nearly even that the rate of technological invention will slow. If so, competitors will likely catch up before the U.S. can leap ahead.

Both the state and the international system as they exist today have been shaped by the development and diffusion of technology. In the world of 2030 to 2050, sources across all of the lenses agreed that technologies in development in 2016 have the potential to change the operational environment and the character of warfare. But the sources diverged on the expected rate of technological invention, that is, the rates at which new technologies emerge and those technologies are paired with concepts that make them useful. Many sources saw a technologically optimistic future in which improvements in autonomous machines, advancements in computing power, and the refinement of additive manufacturing changed the nature of work and, by extension, the use of military force. Yet other, more technologically pessimistic sources diverged on that future, questioning how rapidly – or even if – these systems could emerge and become operational.

The technological pessimistic world has substantial implications for the military. In this world of slowing invention, the continued diffusion of pre-existing technologies – e.g., the integration of low-cost sensors that are interconnected in cyberspace – means that the United States will no longer have a near-monopoly on many of its key military technologies. Thus, the cost of counters to precision-strike drops, as what can be identified can also be disrupted. At the same time, the slowing rate of invention implies that the cost of the next breakthrough technology – which includes the costs of other failed technologies - increases. Put simply, in this world, fully autonomous systems, quantum computing, directed energy, and AI proves more difficult to implement on a battlefield than originally imagined.

Regardless and not surprisingly, technology matters to the future. The SSG found that 502 of the 1,044 sources surveyed (or 48%) indicated that the future operational environment will be shaped by technology. As seen in the table to the right, these technologies include cyber and connectivity, biotechnology, autonomous machines, the proliferation of sensors, additive manufacturing, and, of course, AI. It
<table>
<thead>
<tr>
<th>Percentage</th>
<th>Technology Area</th>
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<tbody>
<tr>
<td>39%</td>
<td>Cyber, Internet, Internet of Things</td>
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<tr>
<td>26%</td>
<td>Connectivity, global information grid, communications</td>
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<tr>
<td>25%</td>
<td>Biotechnology</td>
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<tr>
<td>23%</td>
<td>Autonomous machines or robots</td>
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<tr>
<td>14%</td>
<td>Sensors and their proliferation</td>
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<tr>
<td>13%</td>
<td>Additive manufacturing</td>
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<tr>
<td>10%</td>
<td>Artificial Intelligence</td>
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<tr>
<td>9%</td>
<td>Space and counter space</td>
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<td>7%</td>
<td>Big Data</td>
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<td>5%</td>
<td>Directed energy &amp; hypersonics</td>
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<td>4%</td>
<td>Quantum Computing</td>
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<tr>
<td>2%</td>
<td>Ballistic Missiles</td>
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<tr>
<td>1%</td>
<td>Nuclear Proliferation</td>
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* Adds to more than 100% because many of the 502 sources address more than one of the above technological areas.
is noteworthy that existing futures studies’ forecasts highlight these same types of technologies.

By influencing larger political and economic conditions, these technologies shape both strategy formation and resulting military trends. Indeed, in the SSG study, technology trends were a frequently occurring categorical response – across all of the lenses – to these questions: what game-changers could alter the route to 2030 to 2050; what are the global trends shaping the future operational environment; and what are the military trends shaping that environment? The question, therefore, becomes what technologies will emerge in 2030 to 2050.

**Techno-optimism**

Optimists argue that over the next quarter century, the potential of autonomous systems, the (continued) proliferation of low-cost, connected sensors, and additive manufacturing will be realized. These platforms, they state, will fundamentally disrupt society.

Every lens contained sources that strongly argued that the rates of technological invention and innovation are accelerating. In this view, by 2020, it is likely that the proliferation of low-cost sensors and the integration of almost everything into the aptly named Internet of Things (IoT) exponentially increases the amount of available data and allows for major efficiency gains, in part, by enabling more accurate simulations. It is also likely that, by 2030, autonomous drones, self-driving vehicles, and crewless ships fundamentally transform the transportation sector and drastically lower the cost of transportation.

At around the same time, additive manufacturing – which is already past its infancy – combined with those autonomous robots will increase productivity while reducing energy demands and the need for human labor. From this perspective, armies are likely to field automated convoys that self-sustain some of the classes of supply while their combined arms elements employ sensor networks – aggregating both classified and commercial data – to increase situational understanding and the

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**Artificial Intelligence:**

What precisely is AI has been the subject of considerable debate, from the famous Turing Test to today’s attempts at definitions. For this report, AI was divided into three types:

- **Narrow AI:** A single-purpose AI, like IBM’s Watson.
- **Artificial General Intelligence (AGI):** A general ability to learn, reason, and adapt to different conditions. This is somewhat like human general intelligence, and it would allow a machine to successfully perform any intellectual task that a human being can. It is the primary goal of AI researchers.
- **Artificial Super Intelligence (ASI):** Surpasses human intelligence by all definitions.
efficacy of fires and maneuver. In the extreme, the ratio of soldiers-to-unmanned-equipment shifts to 1:10, as companies of 20 people field 200 ground and air unmanned systems that perform ISR, direct and indirect fires, and sustainment.

Arguably the most important potential technology of all is AI. An AI, at least theoretically, would overcome the four challenges of data processing – scale, speed, complexity, and endurance – necessary to analyze the increasing data from connected sensors.15 Several more-optimistic sources forecast the emergence of a general AI between the years of 2030 to 2050, with 2040 as the most likely time period.16 Such an emergence could be driven by advancements in quantum computing, and techo-optimistic sources suggest that quantum computing will be developed to the point at which it is enabled for broad applications by 2036.17

To be sure, there was disagreement about what does, or will, constitute a true AI.18 But from self-driving cars to IBM’s “Watson” and Apple’s “Siri,” early forms of AI already exist in 2016. Although these are limited applications of AI’s promise, when considered in light of increases in computing power – especially the potential for quantum computing – optimists describe the chances of developing a far more powerful and comprehensive AI within the next quarter century as likely. Indeed, within the private-sector lens, one company’s chief executive officer argued that a version of AI already exists.

Several sources noted that the emergence of AI may be the single most disruptive technology between 2030 and 2050. Even incremental improvements in the primitive AI of 2016 will almost certainly allow for further exploitation of the immense data flows that are likely to be generated by connected sensors. This data exploitation will likely allow staffs to understand complex relationship patterns and therefore predict behavior. For example, in 2016, Amazon can primitively predict what books a consumer might want to read and adjusts its supply chain accordingly. If this technology trend continues, in 2030, a military fielding AI could very likely anticipate some action-reaction-counteraction cycles and act appropriately in response. Staff networks, not just staff officers, will likely learn and accelerate transitions in the observation, orientation, decision, and action (or OODA) loop.

More importantly, from sources within and across the lenses, it appeared that, in many ways, advancements in other technologies like autonomous systems (i.e.,
robots), additive manufacturing, biotechnology, and advanced materials were dependent on advancements in AI. In part, it may be that only an AI could handle the complexities inherent in the further development of these technologies. To use an example, an AI would almost certainly be better than a human researcher at predicting the influence of modified genes in a complex environment. This ability to accurately simulate modified genes’ influence appears to be a necessary prerequisite to substantial genetic modifications and even human enhancements.

From automated staffs and mission command functions to autonomous kill chains and robot soldiers that execute fire and maneuver, AI’s potential effect on the battlefield should not be understated. Artificial intelligence, alongside emerging concepts on how to employ this capability on the battlefield, could reshape the character of warfare to a degree as significant as the development of the airplane. Of course, this assumes, as optimists do, that this technology will not only emerge but will be developed to the point at which it can be paired with those new concepts and actually employed on a battlefield.

Similarly, sources saw a future shaped also by advancements in cyber and directed-energy technologies, as well as the proliferation of both ballistic missiles and nuclear capabilities. Here the diffusion of knowledge – facilitated by information and communications technologies that already exist – plays a key role. Smaller-scale actors will likely be able to acquire, and even refine, technologies of coercion that had previously been the domain of great powers.

Sources surveyed also highlighted biotechnology, to include gene editing, as a major technological trend. Some of these sources note that empowered by new genetic-engineering techniques, biotechnology seems to be at an inflection point. This technology has tremendous potential for disruptive change across environmental, agricultural, and therapeutic applications, as well as in human enhancement. Such technologies also carry serious potential for abuse. For example, if these technologies continue to emerge, extremist groups could create a genetically engineered weapon of mass destruction with few indications and warnings. The Joint Force currently possesses scant capability to detect and counter such a weapon.

**Techno-skepticism**

Within and across the lenses, there were divergent perspectives regarding the degree to which technology will progress over the next quarter century. Thus, although a minority view, these sources argued that future technology’s promise is over-sold. The sources noted that, for the most part, innovation is incremental.
Breakthroughs cannot be predicted.\(^{21}\) And consequently, the realization of technology’s potential may be more difficult – and time consuming – than technology’s promoters care to admit.

From this perspective, many of the technologies predicted to take off between 2030 and 2050, including AI, may not emerge as promised for want of critical breakthroughs. Some of those technologies, even if successfully demonstrated in the lab or by prototype, may not be cost-effective to scale. They may also prove too fragile for battlefield application. Promising nano-materials, for instance, even if successfully developed, may remain unrealistic to use for anything other than exquisitely expensive niche capabilities until further breakthroughs in production technology emerge.\(^{22}\) Indeed, because gathering the raw materials for a complicated item, like a radio, is inefficient, additive manufacturing itself may remain less practical than mass manufacturing.

This perspective may hold true for other types of technologies as well. Biotechnology holds great promise. But while promoters may be bullish in their promises, such promises do not necessarily resolve into effective therapies or human improvements. Many of the medical advances over the past 25 years have come in the form of devices and procedures, and promised gene therapies have yet to produce any major results.\(^{23}\)

In addition, the end of Moore’s law – which predicted that the processing power of computers would continue to double over regular annual or biannual intervals – indicates that exponential growth in computing power may be coming to an end. Although quantum computing offers the potential to re-energize an increase in computing power’s growth rates, it has not yet been operationalized. It would also

\[\text{Public- vs. Private-Sector Innovation}\]

Many, but not all, private-sector firms appear to innovate incrementally. They make a large number of small bets (i.e., hedge) and take advantage of competitor advances (i.e., second-mover advantage). Public innovation tends to resolve around larger, riskier bets. Although such bets have a high probability of failure, the few successes have significant impacts (e.g., the Internet or the space program).

More than a few private-sector sources discussed the important role of government in funding breakthrough research and suggested that this was not a role the government is filling. One source stated bluntly that “the United States is gradually yielding leadership in global innovation,… [It is] now number four in numbers of patents issued.” The source concluded that “Americans continue smugly to assume that we remain at the forefront of science, technology, and industry and have little, if anything, to learn….”

be unwarranted to understate the challenges of replicating human-like intelligence. As one source stated, “AI will require a lot more pattern recognition than computers are capable of now” and “AI will have to have the ability to reprogram itself, but we have a lot to learn to allow that to work.”

Indeed, some sources in the lenses argued that the present era’s rate of technological change pales in comparison to that experienced from 1870 through the 1920s. This period saw the electrification of society, home plumbing, the development of the internal combustion engine, the advent of mass manufacturing, and the invention of powered flight, just to name a few. At the same time, clean drinking water and other public-health advancements saw a dramatic drop in infant mortality and a consequent increase in life expectancy.

Further, these more skeptical observers argue that the technologies poised to take off now are all things that have been known of for decades. One source suggested all the technologies currently in development that possess the greatest disruptive potential (e.g., autonomous systems, AI, Big Data, etc.) are really derivative of existing inventions. And another source said that much invention today is, essentially, “consolidating the 1960s.”

This more cautious view of technology is reflected in much of the private sector’s approach to invention. During the study, it became clear that with one or two exceptions – notably, Google – the private sector is generally innovating incrementally rather than seeking “leap-ahead” or breakthrough technologies. Thus, most of the companies that were surveyed are working toward improving pre-existing platforms or combining those platforms in new ways.

This approach mitigates risk. Breakthroughs are almost by definition unpredictable, and betting on breakthroughs means accepting the risk that the targeted technology will never materialize. Further, improvements to technologies can be subject to the law of diminishing returns. As one private-sector source said, “It used to be that you could spend a billion dollars and invent a jet engine, but now you spend a billion dollars [just to] get 3% more fuel efficiency.”

In this view of the world, warfare in 2035 looks much like it does in 2016. There are some marginal improvements to pre-existing platforms. The ability of armies to synchronize joint and combined arms effects across domains through mission command, project and sustain forces, maneuver, and collect actionable intelligence will remain the Army’s core competencies, though several functions will be increasingly automated. Tanks will still exist, but they will increasingly operate remotely or be partially autonomous. Artillery will still conduct precision and area fires, just
Put simply, great powers like the U.S. will no longer have a monopoly on command and control, surveillance, and precision-strike technologies. During the 2000s, Russia, China, and major U.S. allies in NATO and East Asia introduced precision-strike capabilities. As the world approaches 2030, it is almost certain that smaller states and even non-state actors will increase the lethality of legacy systems using off-the-shelf technology, namely machine learning, the Internet of Things, and autonomy. Familiar sensor and communication capabilities found in mass-market smartphones will be integrated into new capabilities for aging combined arms systems. The expense of lethality and targeting will likely decline at a rate sufficient to challenge how traditional armies organize and operate. This trend is already manifest in 2016 and very likely to continue in the march to the future.

**Synthesis: The Risk of Big Bets**

The military implications of the debate between techno-optimists and techno-pessimists is especially prescient in a future in which military budgets likely will decline. At its core, what the optimists and the pessimists really disagree on is the rate at which technology will advance. Put simply, how soon will autonomous machines, AI, gene therapies, and other new technologies arrive? The optimists claim that it will be sooner rather than later; the pessimists rejoin that it will be later – perhaps much later – if ever at all. Unfortunately, as long as breakthroughs remain unpredictable, the future state of technology will remain uncertain.

Optimists will argue for expensive science and technology investments in potential – but unproven – technologies. Pessimists will respond that such investments are
riskier than making incremental improvements to proven technologies or combining them in new ways. This debate actually plays out in the private sector as well. In public statements, many private-sector sources were quite bullish about the future progress of technology, and yet, the business case often favors making a hundred smaller bets instead of one big bet.

To put this debate in concrete military terms, if the Army invests in breakthrough technologies, it raises the probability that the potential of those technologies is realized, giving the Army a significant advantage. Further, such an approach reduces the probability that an adversary will develop those same technologies before the Army. But betting on a breakthrough is risky business. There is a possibility that such a technology – even if heavily invested in – is never realized.29 The diffusion of knowledge and the development of other countries’ economies reduces the periods in which the Army would have a monopoly on that technology or the time necessary to counter it. Further, international and domestic laws, policies, and even cultural and organizational or individual interests can act to prevent the adoption of a technology that, although feasible, contravenes those laws, policies, and interests.

When taken together and by way of deduction, there is an even chance that the rate at which technology advances will slow. And absent a counter-vailing increase in the rate at which new concepts are developed for pre-existing technologies, the rate of technological innovation will also slow. As a consequence, the research and development costs for leap-ahead technologies – which includes the costs of failed technologies – will increase, and the return on the investment of research and development funds will fall. Further, the rapid diffusion of knowledge globally and the development of other states’ economies, which allows those states to build advanced technologies, means that even after a leap-ahead technology is developed, the time for which the United States maintains a monopoly on it is likely to be shorter than it was for earlier leap-ahead technologies. That reduced period of monopoly further reduces that rate of return.

Yet even if the rate at which technology advances slows, there will be changes in the technology available on the battlefield. As an initial matter, that rate is only one component of innovation. As noted, innovation is what happens when a technology is combined with a concept that makes that technology useful. A reduction in the number of new technologies can be, to a degree, offset by new concepts that employ existing technologies differently. Moreover, those existing technologies can be combined in new ways, giving rise – when combined with a concept – to different effects, i.e., Uber or, for that matter, the smartphone. And even incremental improvements to today’s technologies can, over time, produce significant change.
In this future, it is likely that increased levels of machine autonomy will emerge by 2030. This battlefield machine autonomy is driven by the continued proliferation of (pre-existing) sensors throughout society and by advancements in machine autonomy across other segments of the economy, most notably in transportation. Thus, around the same time period, it is likely that the transportation sector will see autonomous trucks and cars. That said, it is also unlikely that quantum computing will reach the economies of scale necessary for generalized military applications by 2030. And if a general AI emerges, it is unlikely to occur before 2040. Significant technical challenges remain to be solved.

Finally, it is worth noting that none of this discussion suggests that research into leap-ahead technologies is not justified. In some cases, only the Army will finance research into technologies that it will need to successfully fight in the operational environment of 2030 to 2050; there is no private-sector profit motive, for instance, in building a hoverbike for urban operations. Moreover, as discussed above, the government in general can better bear the costs of investing in such research, and if those leap-ahead technologies are realized by that research, the effect can be an increased rate at which technology advances overall – think the Internet’s impact. Ultimately, therefore, the questions will be what will the Army be called on to do, what will it need, and what can it afford.

The International System

A competitive multipolar system will likely increase strategic competition and the resulting risk of miscalculation between regional powers.

The international system shapes the character of warfare and the circumstances in which future governments will call for the application of landpower. There were two principle areas of convergence across the lenses: the likelihood of a less ordered international system between 2030 and 2050 and the rise of regional challengers to U.S. preeminence. The primary area of divergence was over China’s future, with some concerns about potential shocks in the form of a deep political and/or economic crisis. Together, this suggests an international system characterized by greater instability and competition.

A Multipolar Future

Across all lenses, there was a significant convergence on the idea that the international system will become more fragmented between 2030 and 2050. Of the 211 sources that described the future international order, 79% envisioned a future in
What are the resulting concepts for the international order in 2030-2050?

The International System: A Tale of Two Futures

- Integrated, cooperative, multipolar: A system that adapts to the changing power balances while maintaining its key post-World War II structures.
- Fragmented, competitive, multipolar: Competing centers of power increasingly make any cooperation difficult to impossible.

In particular, it is likely that by 2030, the international system will be more multipolar than it is today. Indeed, approximately half of the sources used the term “multipolar” to characterize the future international order, while 30% of sources indicated that there would be a general erosion of order globally. Despite the United States remaining the world’s most powerful state, other states will play important roles in regional security and global rule-shaping – most notably China.
The sources almost universally agreed that China would emerge as a pole in that future system. Russia, India, and the European Union were also mentioned by many sources, while Indonesia, Japan, Iran, Turkey, Poland, Nigeria, South Africa, Brazil, and even ASEAN received some mention, albeit far less often.

Even in a multipolar world, the U.S. will likely maintain a privileged position. Sources across the four lenses described the United States in 2030 and beyond as the “first among equals,” “the world’s indispensable nation,” “a dominant power . . . regardless of how you want to define dominance,” “the only global superpower,” “the world’s only superpower,” and “the most powerful and influential nation.” Nonetheless, many sources also explained that while the United States will likely still occupy a “unique position,” it will no longer be “hegemonic” due to the rise of regional competitors.

What the sources disagreed on, however, was what that portended for the U.S.-led international system. Across the lenses, and even, at times, within individual sources themselves, there are a range of possibilities regarding the future of the American-led Western international order. The most optimistic view is that revisions to the international system will be adopted that reflect new realities but maintain the key principles of the current order. Those revisions could come in the form of improvements to major international organizations. Or the international system could be reinvented such that states form ad hoc coalitions to manage international challenges, ranging from resource scarcity and climate change to a nuclear Iran. In this world, landpower would likely play a smaller role as part of a (diminished) conventional deterrent and as a limited expeditionary force for specific limited-duration warfare. Similar to that of the early 1990s, the operating tempo would be high, the budgets low, and the mix of capabilities required for contingencies consisting of lighter formations (e.g., SOF and enablers) optimized for wide-area security.

More pessimistic views emerged as well. First, some of the sources in the private sector and competitor lenses suggest that the international system will be shaped by “rising regional hegemons . . . [that] use their growing influence to shape their respective regions.” Other accounts described this as “regionalized globalization.” This process is essentially a re-emergence of spheres of influence. Even if the United States retained its role as the globe’s most important state, the world would likely see a return to competing centers of power. More pessimistically still, some sources see the potential for an erosion of standing institutions of international order, or a “G-Zero world,” which is defined as “one in which no single country or bloc of countries has the political and economic leverage—or will—to drive a truly international agenda.” In either of these worlds, the Army would likely
The Character of Warfare 2030 to 2050

play a larger role through forward presence to deter major theater war, reassure allies, and shape events before the outbreak of a militarized dispute. Similar to the 1980s, the mix of capabilities needed for these missions would likely require armored formations that are optimized for combined arms.

These competing visions of world order shape the character of warfare and through it, the optimal mix of land forces required to secure U.S. national interests. The Chief of Staff in 2033 will likely still confront the same strategic dilemma that has confronted Chiefs since the end of Vietnam: What is the core competency that should guide force-structure decisions and requirement generation – combined arms or wide-area security?

The Future of China

The most likely peer competitor in 2030 to 2050 is China. Russia – though a military threat – will almost certainly continue to be a state in decline, albeit a state that will continue to challenge the U.S., NATO, and other allies. Consequently, it is China that will likely have the greatest impact on the configuration of the international system over the next quarter century, and fittingly, China was mentioned more than any other state or concept in the responses.35 As one source stated: “More than any other factor . . . the global role China chooses to play and the character of the U.S.-China relations will shape the contours of the international system.”36 Fundamentally, the question is whether China works within or challenges that system.

China will matter even if it does not attain the same status that the U.S. has occupied over the past two decades. The majority of sources discussing China, albeit not all, believe it is likely that China’s economic, military, and geopolitical in-

A Tale of Two Power Transitions

Power transition theory holds that an “even distribution of political, economic, and military capabilities between contending groups of states is likely to increase the probability of war . . . The aggressor will come from a small group of dissatisfied strong countries; and it is the weaker, rather than the stronger, power that is most likely to be the aggressor.”

Power transition theorists argue that the two World Wars were attempts by Germany to displace the U.K. as the global hegemon. They see the rise of China as likely to produce future great-power conflict in the 2030 to 2050.

Alternatively, the China-U.S. relationship could evolve similarly to the power transition between the U.S. and the U.K. in the 19th and early 20th centuries. These two former adversaries integrated economically and eventually formed a lasting alliance.

- * D. Lemke, Regions of War and Peace (2002)
- **For more about competing perspectives on whether the U.S. and China are in a power transition, see:
  - David Lai, The United States and China in Power Transition
  - Steve Chen, China, the US and the Power Transition Theory: A Critique
Technological Change, the International System, and the State

Influence will continue to rise over the next 15 years and beyond. Significantly, no source believed that China would become the dominant global power. Instead, by 2030, it is fair to say that most sources expect China to be the significant military power within its region and also, due to its economic might, to be able to influence how the international system is organized and run.

That said, there was a divergence among the lenses concerning how China would shape that system. Some believe – mostly sources within the U.S. government – that China will “challenge the current world order,” “work to change the rules and minimize U.S. influence,” and “seek a new world order.” In such a power transition, the probability of great-power conflict likely increases, but the Army plays a supporting role in joint task forces that will seek to shape and deter Chinese aggression. In this world, air defense, intelligence, cyber, aviation, and expeditionary sustainment would likely become the critical enablers the Joint Forces requests from the Army.

Others argue that China will “blend with the existing world and international order.” In this regard, sources noted that China’s overseas actions – outside of its bordering states – tend to be taken to secure resources or make investments. Indeed, China’s increasing foreign infrastructure investments and its reliance on trade make it unlikely to risk conflict except in self-defense, although it may view acts to protect its extraterritorial economic interests as such. In this world, the probability of great-power conflict is diminished, and the demand signal for military forces that are optimized for major theater war in Asia declines.

Regardless, China will face significant challenges, some of which it will share with the United States. Chinese growth is likely to slow significantly from 2020 to sometime in the 2030s due to demographic factors and a shift away from export-driven growth to domestic consumption. China’s work force will have peaked in 2016 and will drop by up to 16% over the next 30 years. While the U.S. will stay demographically healthier than China over the next generation, both countries will feel the squeeze of geriatric spending commitments, which may crowd out military spending. Consequently, China will likely face domestic pressures that

PLA-Induced Crisis
One cause of a political crisis in China bears special mention: a crisis precipitated by the People’s Liberation Army (PLA). One source from the allies lens said, “There are also concerns that civilian control over the PLA may be growing weaker and some evidence of a divergence of views between political and economic elites, on the one hand, and the military, on the other, regarding the degree of assertiveness China should display in its international affairs.” In this regard, a professor stated that the PLA may take action to “restore stability due to a weak civilian leader.”
limit Beijing’s incentives to challenge the U.S. globally between 2030 and 2049, which is the 100th anniversary of the Communist revolution.

Finally, although considered unlikely, sources in the U.S., allies, and competitor lenses stated that the a deep crisis challenging the Chinese Communist Party (CCP) was at least possible during the next quarter century. The crisis could be triggered by an economic recession or a slowdown that limits China’s ability to ensure an acceptable level of income equality across its population. Further, such a crisis could be precipitated by an environmental catastrophe. Indeed, “any environmental development ([e.g.,] rising seas) that significantly affects the coastal region of China would be severely detrimental to [its] continued development,” as the “coastal region represents the majority of industrial, intellectual and political infrastructure” in China.

Whatever the cause a deep political crisis in China would be a significant shock. China is now the world’s second largest economy, and by 2030, odds are even that it will be the world’s largest economy. It is simply unrealistic to expect that such a crisis would not be damaging to other economies, including the United States’. A significant crisis in China would very likely trigger a global economic crisis, which, like the Great Depression, has the potential to trigger nationalistic power struggles and international crises.

In light of these challenges, current Chinese leaders likely define future “success” as: politically, the CCP remains in power; economically, they have instituted an approach to sustainable development for the nation’s economy; socially, they have successfully integrated their population into that model; militarily, their armed forces are world class; and geo-strategically, they share the Pacific region peacefully with the U.S. To achieve these goals, it seems more likely that China, like other rising powers, will use its influence to bend or change the rules to favor itself but that it will not seek to build a wholesale alternative to the current international system. In such a world, military force is likely more limited and predominately used in support of larger political and economic strategies.

Finally, although not mentioned nearly as universally as China, sources frequently mention India as a rising regional power during the next quarter century. India will not go through the same demographic throes as China, but some sources argue that it is likely that India will make significant catch-up gains on both China and the United States during that period. By 2040, the three countries’ economies could be roughly the same size, and India will have somewhat of an advantage over China due to its relatively youthful average age (34) compared with the latter (46).
As Indian economic and military power grow, there is an even chance that it leads to increased competition with China beyond their existing rivalry in 2016. While not a direct threat to the U.S. military, this competition would likely destabilize South and Southeast Asia.

**Governance and the State**

Supra- and sub-state actors will very likely continue to challenge the governance capacity of the state from above and below. It will be easy for these actors to organize, and unrest will be cheap.

In the world of 2030 to 2050, the state, while remaining the major power broker in the international system, will likely be weaker than it is today, both domestically and globally. The modern state was born in the Peace of Westphalia at the end of the Thirty Years War and reaffirmed at the end of the Second World War, when the United Nations charter declared that state borders were, essentially, inviolable. And the state remains the basic organizational element of the international system. Yet across most of the lenses, there was an agreement that the state is changing. Power is diffusing from the state, and this diffusion is occurring just as the state (both democratic and authoritarian) faces significant governance challenges, ranging from aging societies to inequality to megacities and scarcity.

**Power Diffusion**

As described in sources within and among the lenses, power is diffusing from the state. Power is being pulled upward to supra-national organizations while simultaneously devolving downward to technology-enabled non-government organizations and individuals. In essence, sources described states as having their power “eroded” or “nibbled at.” In many of its publications, the Atlantic Council describes this as a “Westphalian-plus” world – one in which states must negotiate with both other states and non-state actors at the same time. The result is a tendency toward a weaker state.\(^{57}\)
First, power is being pulled upward to supra-national organizations, such as the United Nations, the European Union, the World Trade Organization, and others. This effect has been furthered by globalization - itself much enabled by transportation and communication technology, at least in its modern version. Globalization also integrates states’ economies more closely and, in some cases, states’ populations. Further, this upward pull of power has been catalyzed by global environmental degradation, in particular climate change, and other circumstances in which effective solutions to these problems are also effectively international in character. These supra-national groups and challenges tend to pressure states and limit their sovereign freedom of action. In the future, international organizations and non-government networks will very likely seek to limit the application of landpower while also informing rules of engagement. There will be an increasing array of international norms governing how commanders fight.

Second, power is being devolved downward to a range of sub-state actors, including powerful cities, mega-corporations, transnational criminal organizations, non-governmental organizations, and even super-empowered individuals. In many cases, it was technology that enabled the rise of these actors. Information systems allow individuals to identify other like-minded individuals quickly, and technology has also reduced the cost of communication to effectively nothing. It is consequently easier to organize now than it was before. Since pre-existing technologies enabled these groups, it is unlikely that even a slowing in the pace of invention will reverse this trend. From social movements to activists, these groups can also limit the application of landpower. For instance, a global movement may successfully pressure some countries to ban autonomous combat systems even as other countries continue to develop them.

The diffusion of state power implies a breakdown in domestic authority, making it easier for organizations and groups to mobilize and use violent and non-violent means to challenge government officials. At the same time, the state’s ability to use violence is restrained by empowered actors employing a variety of means, ranging from lawsuits to treaties to public relations and to even insurrections. In this world, landpower is likely to be called upon to perform wide-area security operations – all under the watchful eye of these very same organizations.

**Governance Challenges**

*The World of 2030 to 2050: Young, Unemployed, Urban, and Angry*

Exacerbating the effects of power diffusion, sources within and across the lenses identify trends that will create significant governance challenges for states over the
next quarter century. These sources indicate that those challenges include changes to states’ demographic characteristics; the growth of inequality; the influence of megacities; and the possibility of renewed, or at least increased, resource competition. As a consequence, many sources noted that there was the real possibility of further state failures. Indeed, some sources openly questioned whether governments – both democratic and authoritarian – were up to the plethora of challenges that will be thrown their way in the coming decades.

In the early 1990s, a mix of national-security thinkers and academics started to focus on trends that undermine a state’s ability to govern and lead to political instability and ultimately state failure. Many of the trends identified by the sources surveyed in this study are similar to factors predicted to weaken the state after the Cold War. From environmental-scarcity challenges to grievances emerging from corruption and inequality, there have been, and will very likely continue to be, forces that undermine a state’s ability to govern. There is more continuity than change in this regard.

What might change in the world of 2030 to 2050 is the degree to which states will have to negotiate with a multitude of stakeholders before acting. Put simply, there will be more veto holders. This trend is visible in 2016 in the presence of global activities on mobile platforms and social media. In some circumstances, achieving the necessary concurrence from those stakeholders to act may be difficult to outright impossible. The effect is that managing these complex challenges will become even more complicated.

Several states face significant demographic challenges. Across all four lenses, of the 372 sources that cited social trends, the single-most frequently mentioned social trend is demographic change. Japan, South Korea, China, and Europe are all graying, and so is the United States, just to a lesser extent. This is a consequence of two facts: people are living longer, while developed countries have experienced a fall in birthrates. The fall in the birthrate is driven by an increase in female labor-force participation, the reduced utility of a large family, and the increasing cost of rearing children in a middle-class society. The United States, Western Europe, and East Asia will all very likely see an increase in the median age and a consequent “graying” of their populations.

First, “graying” states will very likely increase government spending on elder care. In addition, without off-setting productivity gains, fewer workers will mean slower economic growth. As a result, many states will face significant difficulties in repaying their national debts while still meeting entitlement promises. Such budget pressures will influence the guns-or-butter debate, and there will be
In 19th century England, high levels of inequality led to different physical characteristics in the military population. A 14-year-old entrant to Sandhurst, reflecting the more aristocratic population, averaged 5 feet 1 inch. In contrast, 14-year-old enlisted recruits at London’s Marine Society, indicative of the city’s poor, averaged 4 feet 3 inches tall.*

* Charles Tilly, Durable Inequality (Univ. of California Press, Sept. 1999).

Megacities

The number of cities with a population in excess of 10 million – a common cut-off point for a city to become a “megacity” – will grow along with the overall urbanization percentage*:

- 1950: 2 megacities
- 1990: World is 45% urbanized
- 2005: 20 megacities
- 2015: World is 54% urbanized
- 2030: 41 megacities
- 2050: World is 66% urbanized

Megacites was the subject of the CSA’s Strategic Studies Group Cohorts II and III.


Indeed, the pace of inequality growth may well quicken if the promise of some technologies in development is more fully realized. These technologies include additive manufacturing, automation and robotics, and, of course, narrow or general AI. In such a world, the rich will likely live longer and better; they may have robots and other devices (exoskeletons) to aid them as they age. In contrast, the poor will be increasingly limited by lower education and even nutrition, and will have considerably fewer job prospects. Even if policies are enacted that more equally
distribute technology-driven productivity gains, it is very possible that the loss of status that accompanies job loss will aggravate instability.

Although creating many opportunities, the rise of megacities also potentially creates real challenges for states. Megacities are often engines of economic and intellectual activity, and they are critical nodes for the knowledge economy. Cities also enable the rise of a middle class, who, through specialization, are able to maximize the value of their labor. But cities are needy and vulnerable to shocks, and the quality of life they offer can deteriorate quickly due to pollution, congestion, lack of adequate government services, or the shutdown of major employers and industries. Dense urban areas also can easily become incubators for social unrest since they allow the rapid mobilization – facilitated by social networking tools – of a critical mass of people. The trend to urbanization is very likely to continue. The UN projects that by 2050, 66% of the world could be urban. Whether or not that trend leads to major unrest will be a central question for planners.

In the world of 2030 to 2050, chances are even that local food-and-water scarcity will cause instability. Though only a correlation now, food prices surged prior to the Arab Spring, “exposing unprepared governments.” In 2016, the number of net food importing countries is growing while food price volatility is increasing. This scarcity will also almost certainly create future migratory pressures – pressures that will almost certainly increase if a state becomes unstable – and, consequently, future population movements.

Alone or together, resource scarcity and migration will very likely cause governance challenges for sending and receiving states. Certain segments of Africa are likely to see food production significantly lag population growth, though the causes are likely to be domestic conflict, poor governance, and mismanagement rather than a lack of arable land. South Asia is likely to experience problems in both food and water depending on the specific effects of climate change. But ironically, higher agricultural productivity is likely to create additional migratory pressures to cities or other countries if the demand for farm labor drops and reduces the number of rural families who can depend on agriculture for their living.

Of note, sources within the U.S. and allies lenses considered mass migration to be a significant possible shock – the latter perhaps because some of those states are experiencing such migration for the first time in living memory. Migration is a significant governance challenge: one allies-lens source noted that mass migration can cause a “disruptive impact and instability,” and integrating a large number of migrants into a society can be a difficult challenge. Migration may increase to 50 to 100 million refugees during the next 15 years, driven, in part, by climate change.
Finally, there is the effect of climate change itself, which will likely exacerbate these instabilities. For instance, decreasing arable land will likely increase migration. When combined with the presence of inequality in these states, there could be an increase in the frequency of local unrest and political repression, which in turn further accelerates migratory pressures.\textsuperscript{78} Information technology is likely to increase that frequency, as it carries with it the risk that poorer people become aware of, and thereby infuriated with, their relative poverty and now have access to a network of others who share a desire to radicalize.\textsuperscript{79}

Such a world is likely more prone to intrastate conflict. This is consistent with history. As central authorities have weakened, new power centers emerge that challenge that authority. In some circumstances, an accommodation between the government and those new powers is reached – for instance, the Feudal period. But sometimes one is not. In either case, though, ungoverned – or undergoverned – spaces are almost never stable places. In this globalized world, narco and human trafficking, violence, and terrorism likely become significant exports of such (failed) states. In this future, there will likely be an increased demand for stability operations.

**Failing and Failed States**

The diffusion of power combined with these rising challenges to governance leaves the state weakened. As a consequence, many sources readily admit that states with weak governments may very likely fail. By itself, this is not particularly surprising given that, in 2016, there were a number of failed or failing states – Syria, Somalia, Libya, South Sudan, etc. And given these trends and forces, additional state failures should be expected, creating safe havens for transnational criminal organizations and extremists.

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State Failure Taskforce

In 1994, the CIA funded a network of academics to develop a database on instances of domestic instability linked to state failure. Major findings include:*

- Regime type: partial democracies have a higher risk of state failure than authoritarian regimes and democracies;
- International trade reduces the risk of state failure; and
- Infant mortality: lower infant mortality, usually associated with higher standards of living, decreases the risk of state failure.

For the most part, the areas that are most at risk in 2030 are likely to be those most at risk today.\textsuperscript{80} These are fragile, highly unequal states where resource challenges, corruption, and demographics create factional politics and popular discontent. Many of these states are also the most vulnerable to the effects of climate change, which will amplify existing problems and increase migration pressures and unrest. Even some currently stable states in Asia that have strong manufacturing sectors could be undermined by labor displacement, either from migration of those sectors to lower-cost countries or by automation replacing those jobs wholesale.

Although less likely but more concerning, U.S. allies and competitor lenses contained sources indicating that over the next quarter century, the collapse of a medium power was at least possible. Specifically, there was agreement across those lenses that a collapse of the Democratic Republic of Korea\textsuperscript{81} or a major Middle Eastern state was possible.\textsuperscript{82} In any event, such a collapse would upset the international order, destabilize U.S. treaty allies, and potentially result in a global economic crisis.

The reasons for such collapses varied by the state and within the lenses. For North Korea, a collapse could be caused by the fall of the Kim family,\textsuperscript{83} a deeper economic crisis,\textsuperscript{84} or even a South Korean\textsuperscript{85} or Chinese intervention.\textsuperscript{86} In the case of a major Middle Eastern state, a fall could be the consequence of (further) falling oil prices and an economy that has failed to diversify.\textsuperscript{87}

A collapse of any of those powers would have military implications. A North Korean collapse could degrade South Korean stability,\textsuperscript{88} and it could harken Chinese involvement that precludes further South Korean and U.S. presence in that territory.\textsuperscript{89} As one source noted, “Northeast Asia is the fulcrum . . . . If the Korean peninsula is in disequilibrium, conflict results. Multiple major wars, from the First Sino-Japanese War to the Russo-Japanese War and the 1950 Chinese intervention in the Korean War, involved questions over who would control this strategic terrain.”\textsuperscript{90} Further, if the economy of some large Middle Eastern states remains significantly dependent

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**From Local to Global War**

In his History of the Peloponnesian War, Thucydides describes how the rising power of Athens alongside a localized dispute trigger the conflict. Specifically, Thucydides discusses how the civil war in Corcyra erodes order at two levels. At the domestic level, “war takes away the easy supply of daily wants, and so proves a rough master, that brings most men’s characters to a level with their fortunes.” At the international level, Athens allies with Corcyra against Corinth knowing it could trigger a war with Sparta in order to keep Corcyra’s large navy out of Spartan hands. Expectations of future war and miscalculation in the present can cause otherwise localized conflicts and crises to pull great powers into conflict.
on oil, the collapse of the regime would likely cause a significant increase in oil prices, even if shale oil production may (eventually) mitigate that price surge. It is unlikely that a replacement government would be as receptive to U.S. interests.

Taken together, these trends imply that although there will be interstate competition, the major struggles of the 21st century will likely be between communities within states and between people and their governments. Other states will leverage cyber and other more traditional forms of repression. This will improve stability in the short term but at the cost of increasing long-term tensions. The world of 2030 will continue to see ungoverned or less than governed spaces in several areas complete with attendant security problems.91 To the extent that these localized disputes occur along geopolitical fault lines or trigger larger alliance networks, there is a possibility they could escalate into larger crises between major powers.
Understanding the Future Operational Environment

While the nature of war remains constant, its character changes in each epoch. Specifically, the interaction of the rate of technological invention, the composition of the international system, and the governance capacity of the state determine where, when, why, and how political actors will use “force to compel” their adversaries. The SSG’s study indicates a future with more conflict among an increasing variety of actors.

The sources generally forecast that the years 2030 to 2050 will likely see an increase in the level of conflict over that which was seen in 2016. Driven by emerging technologies, a changing international system, and a weakening of the state, those conflicts will likely be a mixture of interstate and intrastate wars, with “gray zone” and international but non-state conflicts straddling an increasingly fuzzy border between the two. In response, states will likely resort to traditional hedging and shaping strategies. While a major theater war is unlikely in this future, that possibility cannot be eliminated. In sum, in a more fragmented world, conflict is more likely, but such conflict is also likely to be on a smaller scale.

Future Conflict

A changing international order and the proliferation of technologies that both increase lethality and lower the costs of challenging states like the U.S. will likely result in increased levels of conflict in 2030 to 2050. Specifically, 67% of sources envisioned a future with higher levels of conflict during 2030 to 2050 than in 2015. In addition, the majority of responses saw a future characterized by a mix of interstate and intrastate conflict, although most did not see a major theater war. Thus, for the 2030 to 2050 period, 50% of sources described a future in which it was likely that the U.S. Army would continue to be involved in conflicts across the range of military operations, countering both state competitors and targeting non-state actors.

In terms of location, the sources saw future conflict as most likely distributed predominantly in PACOM (34%), AFRICOM (21%) and CENTCOM (18%). In PACOM, the most likely areas to see conflict were the South China Sea and Southeast Asia (12%) and East Asia (11%). In AFRICOM, those areas were Sub-Saharan Africa (6%)
and North Africa (4%). Of note, despite the hostilities in Ukraine and continued Russian aggression and military modernization in 2016, only 16% of sources forecast future conflict in Europe.

These data points do not necessarily indicate that there will be less conflict in Eastern Europe and the Baltics, for example, or that conflict levels are guaranteed to be higher than in 2016. Rather, they aggregate the sources surveyed. The sources examined seem to focus on particular flashpoints and appear to assume that the same triggers for conflict in 2016 will persist, or even grow, in 2030.

The most likely type of future conflict is “mixed.” Thus, in this time period, conflict will involve a combination of interstate competition (e.g., forward deployed or postured conventional deterrent forces, initial entry forces, and combined arms capabilities required to fight a major theater war even if such a conflict is unlikely to occur) and intrastate contingencies (e.g., crisis response, foreign internal defense,
and stability operations). Overall, 50% of the sources indicated this mixed future, while 33% indicated the future would consist predominantly of intrastate conflict and 17% saw a future defined by interstate conflict.

The themes of increasing great- and rising-power competition and interstate conflict resounded across all of the lenses. For several sources, a mix of changing rules and rising powers will result in increased state rivalry. Further, many sources argued that the necessity to secure resources for economic growth will drive some of this increase. In interviews with members of the Chicago Mercantile Exchange, for example, business leaders saw a future in which "resource-rich regions of the world will become hotbeds for conflict. Areas such as Africa and South America are expected to experience conflict as regions fight for their resources." Finally, by way of deduction, such an increase could be the result of the actions of a state’s ally that “pulls in” that state, leading to an interstate confrontation or even a conflict.

The increase in interstate competition may also be driven by “the diffusion of the tools of violence,” which “become simpler, cheaper, easier to acquire, and easier to use.” The increasing availability of multiple technologies has the potential to lower the cost of (effective) violence. These technologies include precision-strike systems and sensors. In 2030 to 2050, they also could include a primitive AI that automates command networks and some attack platforms. Further, they would provide low-cost means of countering legacy U.S. military systems. These trends are unlikely to abate over the next quarter century.

There were multiple divergent perspectives on the relationship between technology and conflict in the future. These divergent perspectives predominantly emerged from the private sector and nonprofit arena. According to one participant from the private sector, “For the first time in human history, predicting violence may be possible. This capability will only improve into the future (2020-2030)” and will allow states to identify and prevent violence. If this occurs, security services may be able to leverage Big Data for both peace-keeping abroad and political suppression at home.

When interstate conflict occurs, sources foresee an increasing use of Russian-style “New Generation warfare,” combining conventional and unconventional methods in a campaign that weights political and economic coercion in a 4:1 ratio to military force and in which the information domain is prioritized. This practice can also be seen in Iran’s support of proxies. From supplying surrogates with arms to providing them intelligence and training, Iran uses coercive measures short of major theater war to advance its interests. The mix of a strategic deterrent and high-capabili-
ty proxies offers revisionist states a means of using conflict to advance their interests short of escalating into major theater war.

Sources also predict an increase in the number of intrastate conflicts during the 2030 to 2050 time frame. Within the lenses, sources offered a variety of reasons for that increase. These reasons include the negative impacts of climate change, or increasing populations that put too great a strain on infrastructure, including security services. Indeed, according to a mix of private-sector

### Conflict, Confrontation, Competition

Aggressive actions between powers can fall on a spectrum, which runs from a diplomatic démarche all the way to a major theater war. For the purpose of this report, these three broad—and admittedly overlapping—categories of action are used:

- **Competition:** The use of instruments of power short of direct threats, including the displays of military power to signal to competitors.
- **Confrontation:** The threat, display, or limited use of force short of war.
- **Conflict:** Significant acts of political violence that involve the use of force by organized groups and that result in a significant number of deaths.
technology leaders and non-profits, “tomorrow’s instability is these growing urbanized environments in the Global South” because those “rapidly growing cities are growing beyond the government’s ability to handle them. Urbanized environments will be too large for any local system to govern, and this is where instability will grow.”

The proliferation of information technology reinforces this trend. Systems that connect users around the world reduce the cost to organize. This will likely provoke a counter-reaction from states, especially authoritarian states, which will seek to control these communications channels and, therefore, increase the costs of organizing, at least organizing for a purpose that is prohibited by those states. But insurgents, terrorists, and even protesters are both cheap and plentiful. Enabled by information technology, so-called “conflict entrepreneurs” may use ideological and religious narratives to mobilize disaffected populations that are more susceptible to violence because of climate change, migration, food insecurity, water shortages, and economic crises.

Further, non-state actors who are motivated by ideological or sectarian reasons are also increasingly becoming transnational criminal organizations as well. Because they cannot openly participate in the formal economy, such groups rely on illegal activities to provide their operating revenue. Even groups that began as local criminal organizations have branched out their operations to “diversify” their revenue streams. Technologically enabled, these organizations both promote instability in the international system and – simultaneously – weaken domestic governance structures. An Army optimized to counter such groups would almost certainly look markedly different than an Army designed to fight and win major theater wars.

### U.S. Impacts

The United States and other democratic nations also must cope with the impact of technological-enabled sub-state groups. Although democratic governments offer avenues to incorporate those groups into the political process, it may be that that process is insufficiently flexible or too slow for such groups. Put simply, there should be no assumption that the United States is immune here.

The United States and other democratic nations also must cope with the impact of technological-enabled sub-state groups. Although democratic governments offer avenues to incorporate those groups into the political process, it may be that that process is insufficiently flexible or too slow for such groups. Put simply, there should be no assumption that the United States is immune here.

Hedging and Shaping

Across the lenses, sources suggested that traditional deterrent postures will likely prevail in the world of 2030 to 2050. Two distinct types of hedging emerged in these responses: hedging through military capabilities and hedging through the use of integrated economic and political networks to limit a competitor’s influence. In combination, the effect of these hedging strategies is to diminish the probability...
of a major theater war while increasing the number of limited clashes, proxy wars, and troop deployments designed to demonstrate resolve in future crises.

First, states will almost certainly continue to deter traditional military threats through a mix of high-end military capabilities. In particular, the world of 2030 to 2050 will see an increase in the spread of strategic-deterrent capabilities beyond the great powers; these capabilities include nuclear weapons, but also precision conventional strike and counter-space assets, as well as offensive cyber and cyber-ISR platforms. In practical terms, this makes it unlikely that the United States will be able to execute a 2003 OIF-type invasion as rapidly or effectively because the U.S.’s APODs and SPODs will likely be ranged by conventional fire.

Further, in 2030 to 2050, even low-end competitors will have access to a network of intermediate range delivery systems targeted by platforms that range from (less likely) nano-satellites to (more likely) commercial surveillance sensors. Precision anti-tank and anti-air capabilities, used alongside GPS denial and electronic warfare assets, will limit traditional tactical and operational mobility. Similarly, cyber warfare assets will become even more readily available. And unless there is a significant increase in states’ ability to protect critical infrastructure, such systems will give even small political actors – including non-state actors – the capability to threaten the sinews of advanced economies.

Second, it is likely that states and other competitors will use political and economic threats and inducements to alter adversary behavior. By way of deduction, the overlapping economic and political networks arising from a globalized economy on one hand but with a potentially more fractured international system on the other increase smaller states’ ability to engage in coercive diplomacy. Of note, this tends to give smaller states the ability to balance the interests of competing great- and rising-powers and moderate the range of coercive actions that those powers apply in their neighborhoods. These developments have the potential to constrain major theater war.

The Ascendancy of the Defense

This type of environment suggests that the strategic defensive will have the advantage. But the ascendency of the defense does not necessarily stop conflict. A widespread ability to conduct operational fires and threaten nuclear retaliation limits the probability of direct attacks and major theater war but also increases the probability that actors will use indirect means and minor conflicts to advance their interests. A modern example is the India-Pakistan relationship in which crisis-level mobilizations, proxy war, and border clashes occur but without the use of nuclear weapons or major theater war.
Similarly, in 2030 to 2050, regional powers will be able to use their economic and political relationships to produce effects that reinforce the strategic defense. Because countries are interconnected, they can use the resulting dependencies to influence other actors. Russia can threaten to “shut off gas exports”; China will use its economic relationships with U.S. partners to drive a wedge into the alliance network. The effects will likely be to decrease the potential for major theater war by raising the cost of such a war but also to increase the likelihood of limited clashes and proxy war, along with the deployment of troops to signal resolve and maintain deterrence.

Like hedging trends, sources across the four lenses suggest that shaping in 2030 to 2050 will resemble shaping activities in 2016. Sources indicate a fairly even distribution of shaping actions ranging from political and diplomatic (33%) to economic (13%) and military (17%). As such, the sources indicate the use of three predominant forms of shaping strategies: partner and alliance networks, resource exploitation, and military blackmail. Chances are even that future competitors will threaten limited conventional action or nuclear escalation to compel the United States short of major theater war.

To borrow Mark Twain’s words, the reports – or arguments – that military force is dead are greatly exaggerated. Multiple actors will continue to see utility in military force to shape the international security environment in the world of 2030 to 2050. Military power will also shape a larger array of diplomatic and economic instruments used to create spheres of influence. Further, higher-end capabilities still matter in the world of 2030 to 2050. Military shaping, even in a supporting role, will likely rest on the proliferation of nuclear weapons, ballistic missiles, and precision-strike technologies – which will be enhanced by cyber capabilities. Seen through an anti-access/area denial (A2/AD) framework, these systems tilt the offense-defense balance in favor of the defense. In 2030, it will likely be easier to defend or deny terrain than it will be to seize it. Further, regardless of the rate at which technology advances, pre-existing technologies – like information and communication technology – will ensure that any new concepts also diffuse rapidly to competitors. This will shorten the action, reaction, counter-action cycle.

There is a divergence among the lenses on the effectiveness of newer high-end capabilities. Responses through a United States lens see a world in 2030-2050 in which a successful Third Offset shifts the offense-defense balance to favoring large-scale power projection – or at least increasing the utility of such forces. But responses through a competitor lens envision an approach to military shaping predicated on comparative advantage in which other actors – i.e., Russia and China – leverage a second-mover advantage by allowing the United States to assume
The Character of Warfare 2030 to 2050

the costs and risk associated with developing whole new offsets. These actors let the U.S. assume the sunk costs of expensive new technologies while incrementally improving or combing existing capabilities and, thanks to knowledge diffusion and their own advanced economies, quickly adapting or countering those new offsets. In the world of 2030 to 2050, the cost of invention could outpace the anticipated military gain. As a consequence, the U.S. must improve its ability to protect its first-mover technologies, to the extent that it can, and improve its offensive capabilities to disrupt competitors’ efforts to adopt such technologies into their own militaries.

The most likely shaping objective for regional powers in 2030 to 2050 will be to establish a sphere of influence in order to secure their interests in the decaying international system. These spheres of influence will support regional powers’ efforts to create a multipolar world. In this world, the United States provides most of the global public goods, but regional powers have a higher degree of autonomy. To put it another way, regional powers will want the benefits of a (weakened) U.S.-led international order but want that system to be altered sufficiently that it allows for defined spheres of influence and defensive buffer zones. They would see this development as giving them the power position they need to effectively veto U.S. actions in their spheres of influence.

With respect to shaping, a significant gap in the study involves how non-state actors shape the international environment. Most sources tend to focus on the United States, China, and Russia. In contrast, the growth of multinational firms, many of which have annual revenues that exceed middle-income country GDPs, and global social movements from Anonymous to activist networks in the Arab Spring would seem to augur a larger role for these non-state actors in the future. In fact, most major futures studies since the 1970s predicted an increased role for non-state actors resulting from the diffusion of power. Yet in discussions on shaping and hedging, the responses collected in the database disproportionately focus on states and particularly larger regional powers. In such a world, conflict may actually prove less likely - despite the sources surveyed - and arise more as a result of miscalculation than premeditated war plans.

In 2030 to 2050, the United States will most likely remain the most important power but not a hegemonic one. Other states will have emerged that are capable of influencing the international system. This may result in a revitalizing of international organizations, or it may “devolve” into a network of regional blocs or even a G-Zero world with no state or organization that has the ability to set the global agenda. Great-power politics will therefore likely matter more than they do today, but in the future, such politics will also likely be interlaced with competing
economic and social interest groups. By way of deduction, in such a world, states are more likely to use limited military force in support of coercive diplomatic efforts than they are to fight major theater wars intended to seize territory.
The Character of Warfare 2030 to 2050

Military Implications

The interaction of a slowing rate of technological invention and its ensuing diffusion, an increasingly competitive multipolar international system, and weakening states will likely lead to increased confrontations between the United States and regional powers, as well as localized unrest and conflicts. This connected world in which knowledge disseminates easily will put a premium on the fight for information and alters the offense-defense balance in favor of the defense. In the future, the U.S. will be more constrained than it is today in how it can respond to these trends. It will face an unforgiving window of time in which competitors catch up to U.S. capabilities, and during which a slowing rate of invention and resource constraints limit its ability to leap ahead - all without a corresponding decrease in the demand signal for ground forces.

The Fight for Information

From regional powers to non-state actor networks, future competitors will combine cyber, electronic warfare, information operations, and psychological warfare into a decisive fight for information. Groups will use tailored narratives that are disseminated through social and mass media - employing language and symbols tailored to specific audiences to mobilize segments of targeted populations - to limit U.S. freedom of maneuver.

In this future war, information networks will enable initiative. Actors will set the conditions and define the tempo of operations by combining influence operations with actions that attack an opponent’s ability to exercise mission command. They will use deception, cyber, and counter-ISR to confuse leaders, paralyze decision making, and deny enemy forces the ability to target. At the same time, using these same networks, competitors will be better able to locate U.S. forces and to mass effects at a time and place of their choosing. Conducting reconnaissance and attacking at distance, competitors will seek crippling first blows and force the U.S. to fight from a position of disadvantage all under the watchful eye of media.

Imagine a future crisis with the PLA over a contested Taiwanese presidential election in 2032. The PLA will employ strategic messaging that delegitimizes U.S. support to Taiwan while conducting cyber-espionage that probe U.S. information
networks for vulnerabilities. It will posture military and non-military forces that are designed to signal the risk of escalation as a form of deterrence. Should hostilities break out, it will leverage information superiority to set the tempo. Aided by the tyranny of distance, PLA joint strike forces will prosecute targets faster than the U.S. can respond. The shock and speed of the operation will push U.S. forces into a position of disadvantage.

From violent extremists to transnational criminal groups, non-state actors will also seek to seize the initiative in the information environment. Even in 2016, U.S. forces are on the information defensive, having to deny conspiracies propagated by adversaries. For example, U.S. forces in Iraq must respond to allegations the U.S. “created the Islamic State.” Da’esh/Islamic State sympathizers use cyber ISR to identify names of U.S. military personnel and operate a sophisticated social media network that recruits through channels ranging from Twitter and Facebook to online gaming forums and the dark web.

In this world, competitors have the advantage. Russian and Chinese regimes have a flare for propaganda and experience tailoring messages. VEOs lie with impunity. The U.S. will have to compete in a global marketplace of ideas for the authority to use force in a way these actors do not. Furthermore, future competitors, particularly Russia and China, have invested in concepts and capabilities that preface the importance of information. They argue that achieving information superiority is the main effort in future war. For example, Chinese sources argue that in the 2003 march to Baghdad, information dominance allowed the U.S. to increase the tempo of operations while forcing Iraqi forces to operate from positions of disadvantage.

**Implications:**

- A more holistic view of information warfare will be necessary to compete and win against advanced competitor concepts. Current Army doctrine identifies information as a tool the commander uses to apply the elements of combat power, while also dividing its components among networks and information protection and inform and influence activities (Mission Command), and information collection (Intelligence). The Army must elevate the priority of information warfare and develop concepts that utilize all information capabilities (Cyber, Electronic Warfare, MISO, etc.) to set conditions for potential U.S. intervention and quickly establish dominance within the competitor’s strategic space.

- Information operations that reinforce the psychological aspects of larger strategic deterrence efforts and partner reassurance help to disrupt
competitor attempts to compel and coerce. Bolstering deterrence efforts with information tailored toward specific actors potentially delays competitor decisions, gaining time and maneuver space for additional force deployments.

- Operational preparation of the environment using forward deployed unconventional warfare (UW) forces alongside conventional assets linked to the intelligence enterprise becomes increasingly important to offset competitor attempts to deny U.S. Joint Combined Arms capabilities. Building the requisite architecture to facilitate future targeting and a larger understanding of regional environment (e.g., population sentiments, economic trends, and political atmospherics) help U.S. forces overcome information disadvantages during a crisis response.

**Ascendancy of the Defense**

U.S. competitors will very likely use the strategic defense to preserve their interests in the future world of 2030 to 2050: regime security, geopolitical position, and economic development. In an effort to preserve freedom of maneuver, these actors will compel one another indirectly by means of interdependent regional and global relationships (economic, political) and will use proxies as fixing forces. Competitors will leverage the threat of strategic escalation involving cyber, ballistic missiles, and nuclear weapons to deter U.S. and Allied intervention. Proliferation of sensors enabling persistent surveillance, PGMs, and increased lethality will dramatically increase the costs of force projection and massing against adversaries. Competitors will attempt to fix an adversary’s mobile strike force, operating from a position of strength that allows them to win by not losing.

Imagine a future crisis against Moscow-backed proxies in the Baltics in 2030 during a Russian presidential election. Russia uses snap exercises and the threat of nuclear escalation while organizing protests and arming proxy groups with capable weapon systems, including remote-controlled mechanized platforms, drones, and air defense systems. They use UW activities to bait their adversary into unfavorable offensive actions that allow Russia to maintain a strategic defense in depth designed to stop escalation and, should conflict breakout, attrite enemy forces before transitioning to a defeat in detail campaign.
Implications:

- The increasing cost of attacking into a defense will make winning the peace increasingly more important. Military options must complement more effective political, economic, and diplomatic deterrence tools that leverage the full range of national power.

- Forces must be able to aggregate and disaggregate quickly with lethality deployed at the lowest level. Protection capabilities will enable units to fight through A2/AD bubbles, operating under the assumption that all space within the defense is susceptible to attack across domains.

- Force packages should seek opportunities to complement existing host nation forces with unique enabler capabilities. Global deterrence against multiple strategic defenses under constrained budgets will be an economy of force mission. Emphasis on forward postured enablers provides flexibility when employing limited maneuver forces. The combined effect of U.S. enablers and allied combined arms teams enables delaying actions while a strike force deploys.

The Unforgiving Window

The U.S. will not be immune to the governance challenges highlighted in this study. As competitors invest in concepts and capabilities that enable them to leverage the fight for information and ascendancy of the defense, the ability of U.S. and its allies to respond to these trends will be limited at best. Graying populations in the United States, Western Europe, and East Asia will drain resources toward entitlement spending. As a result, U.S. defense expenditures, along with those of major allies, will likely decline just as the demand signal for military interventions and forward deployed and postured conventional deterrent forces increase.

Regional competitors like Russia and China, despite their own demographic and budgetary challenges, will continue investing significant resources in defense. Between 2020 and 2030, these actors will catch up before the U.S. leaps ahead, matching precision-strike capabilities and countering U.S. legacy power projection concepts and capabilities with cheap counters and strategic deterreents including cyber, ballistic missiles, and nuclear proliferation. Even non-state actors will likely be able to leverage low-cost commercial solutions that allow them to increase their ability to disrupt U.S. forces.
Around 2030, youth bulges, inequality, urbanization, governance challenges, and climate change create increased demand for stability operations in Africa (most likely), the Middle East, and Central America (less likely). Similar to the early 1990s, there could be a requirement for stability operations on a large scale as complex humanitarian disasters and migration flows break out. The difference will be that in 2030, the U.S. will unlikely retain its command of the commons and the ability to strike at a time and place of its choosing. From regional powers operating through proxies to violent non-state actors leveraging cyber and sensors networks to conduct precision fires, the risks of deploying forces will increase while strategic objectives remain ambiguous.

Imagine a 2030 stability operation in Africa during which U.S. forces deploy to provide security and contain a disease outbreak in a migrant camp in North Africa filled with climate change refugees bound for Europe. Criminal groups and local warlords exploit the population and harass U.S. forces using drones and unmanned sensors built out of old cell phones while using social media to discredit U.S. objectives. These warlords receive actionable intelligence and cyber support from external states. Regional powers like Russia and China use the U.S. deployment as a strategic distraction to suppress dissidents and consolidate regional gains at the expense of U.S. interests.

**Implications:**

- There is a window of strategic risk around 2025 to 2030 in which competitors catch up to U.S. military capabilities and the demand signal for ground forces increases in response to complex humanitarian disasters.

- Investments in capabilities that are agnostic to the operational environment due to their mission (e.g., autonomous logistical resupply, general support aviation, ISR) will provide more operational flexibility.

- Public-private partnerships can facilitate identification of governance factors associated with failing states using Big Data and crowd sourcing. Non-governmental organizations and academic institutions offer opportunities in areas where the U.S. lacks military presence and access to information and local populations. These partnerships facilitate a larger strategic understanding for the U.S. government and potentially provide commanders sufficient warning to shape possible reserve-component mobilizations (e.g., civil affairs, logistics).
Conclusion

The world of 2030 to 2050 will be determined by the rate of invention in critical technologies like AI; the degree to which the international system transitions to a multipolar world; and how existing states manage governance challenges from above and below. More importantly, developments within any of those three broad factors impact the developments within the other two.

As a consequence, the character of warfare in 2030 to 2050 will reflect how these trends combine. The most likely combination is a world of incremental technological improvements in existing systems and the diffusion of knowledge about those improvements globally. This will enable increasing challenges to the U.S.-led international order and a growing number of governance challenges for already fragile states. In short, a world that is not that dissimilar to the world of 2016.

Regarding the rate of technological invention, each period of time possesses a unique “character of innovation.” That character of innovation, in turn, determines the sources of change within the character of warfare, as well as the relative costs of producing those new ways of waging war. Some periods are defined by a technological pull in which inventions from outside of the military are pulled into warfare. For example, during the early 20th century, states found new ways to weaponize the commercially developed internal combustion engine. Alternatively, in other periods, military actors invested in basic research (i.e., S&T accounts) to solve a unique military problem – often creating new technologies that are normally, but not always, subsequently pushed out into the commercial sector. Thus, during the Cold War, Soviet air defenses led the U.S. military to pioneer stealth technology.

In the years of 2030 to 2050, the “character of innovation” may well be most defined by development costs. It is likely that these costs will continue to rise without a promise of producing significant gains. This implies diminishing returns, and it likely means that there will be “less bang for the buck.” The total cost to develop leap-ahead systems – which includes the costs of failed attempts – will likely increase at a higher rate than exploring incremental improvements in fielded weapon systems. If that occurs, it is likely that a second-mover advantage will emerge. States like China and Russia will let the United States incur the sunk costs of developing new technology. They will wait to see what works. By stealing the
few successful ideas, these states make them their own while bearing none of the research and development costs.

At the same time, these competitors will likely face less restrictions on implementing morally ambiguous technological advancements. From biotechnology to autonomous kill systems, these states do not have the same moral, legal, or policy restrictions that the U.S. faces now and is likely to face in 2030 to 2050. Thus even if the U.S. is the first to develop an autonomous attack swarm, it is very likely that it will not be the first to field and use that swarm on the battlefield.

As the world of 2050 approaches, the possibility of game-changing advances in AI becomes more likely. The appearance of even minimal AI has the potential to replace staff functions, shorten the kill chain, and push the tempo of operations to a point at which those operations outpace the capacity of the human mind to process information. Artificial intelligence – when combined with cyber, Big Data, and robotics – creates the possibility of autonomous hunter-killer systems, which are able to predict possible enemy courses of action and take appropriate action. These systems will operate at speeds humans cannot keep up with.

Second, the international system of 2030 to 2050 will likely resemble that system in 2016. The United States will continue to play a predominant role, but it will play that role in a more multipolar world. Assuming the U.S. maintains its existing treaties, that world will require land forces that are optimized to reassure allies, deter major theater war, and shape the environment in a manner that prevents militarized disputes.

But that task will be different, and it will likely be harder. Even if the pace of technological invention is less than the optimists predict, these land forces will operate in a sensor-rich, connected environment that makes operational surprise difficult at best. Further, in the future, regional competitors will possess strategic-deterrent capabilities, including nuclear weapons, offensive cyber systems, counter-space, and precision conventional strike assets that limit U.S. freedom of action. At the same time, these competitors will likely leverage economic and political ties to constrain U.S. military action. The combined effect may be to reduce the Army to a smaller...
role in support of diplomatic and economic statecraft that occurs underneath an extended deterrent umbrella.

And third, that international system will be composed of weakened states, but those states will remain that system’s primary players. States will face competition from supra- and sub-state actors. Technology-enabled groups will be better able to organize and challenge state actions. At the same time, continuing governance challenges will undercut state legitimacy. A weakened state is a state in which instability is more likely to be present, and in this interconnected world, that instability can – and likely will – be exported to neighboring states. The effect is to increase the fracturing of the international system, and it will likely result in a greater demand for both stability and wide-area security operations.

Since the end of the Cold War, a key assumption of U.S. military planning has been the need to construct a force that is capable of responding across the range of military operations. This factor will likely persist into the world of 2030 to 2050. In the future, intrastate conflict linked to fragile states, environmental degradation, and migration is more likely than a major theater war against a near-peer competitor. Small groups will use the current level of connectivity – which will likely grow in the future – to overcome the collective action problem. Thus, the costs of mobilizing will likely continue to decline just as the structural causes of unrest – from economic inequality to corruption and ethnic tensions – increase. The future CSA will have to determine whether to continue using combined arms maneuver as the central organizing principle or optimize the force for higher probability wide-area security and shape the environment core competencies.
Appendices

Appendix A: Trends Table

<table>
<thead>
<tr>
<th>2030 to 2050 Trends</th>
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<td>Technology - slowing rate of change, increasing use of autonomy, AI, and lethal precision</td>
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There is an even chance that the rate of technological change will slow in 2030 to 2050, leading to a situation in which it will be cheaper to innovate by integrating existing capabilities than it is to invent new capabilities.

The proliferation of low-cost sensors and their integration into an Internet of Things will very likely increase the volume of data and the possibility of more refined predictions with economic and battlefield applications after 2020.

Increased levels of battlefield autonomy and automated transportation in the commercial sector are increasingly likely after 2025, but the ability of military actors to use them will vary based on policy, legal restrictions, and cultural norms.

Systems with Artificial General Intelligence–like capabilities are unlikely before 2040.
## 2030 to 2050 Trends

Quantum computing is unlikely to reach economies of scale or favorable price points for broad military application before 2030.

It is almost certain that a larger number of state and non-state actors will have precision-strike and advanced C4ISR capabilities by 2020.

**International System - multipolar, competitive, and defined by regional spheres of influence**

A more competitive, multipolar system in which regional powers challenge U.S. interests is likely before 2030.

China's power will very likely rise, and it is the most likely state, other than the United States, with the capability to shape the international system between 2030 and 2050.

China’s rate of economic growth is likely to continue slowing through 2030.

An internal transition in China is unlikely but possible in 2030 to 2050.

Russia will decline as a state but will very likely continue to challenge the United States between 2030 and 2050 with varying thaws in the relationship.
### 2030 to 2050 Trends

#### Governance - challenged from above and below, climate change, and resource insecurity

- It is highly likely that networks of international organizations and transnational activists will challenge the sovereign authority of states between 2025 and 2050.

- It is highly likely that activists and a range of other interests, from businesses to gangs, will challenge states' authority, leading to more fragile states that are prone to interstate confrontation and intrastate conflict between 2025 and 2050.

- Western Europe, the United States, and East Asia are very likely to see graying populations after 2025, which will limit their ability, and willingness, to invest in defense.

- There is a likely increase in storms that will lead to economic losses and migration after 2025.

- Chances are even that climate change will produce resource and migratory challenges in states after 2025.

- Localized food and water insecurity is likely to create political grievances after 2025.

- States will be increasingly fragile; chances are even that a larger, regional actor will collapse between 2025 and 2030.
### 2030 to 2050 Trends

**Conflict** – *increasing competition and confrontation, limits to power projection, and a new era of instability*

- Increased interstate competition and confrontation and increased intrastate conflict between states is likely in 2025 and 2050

- PACOM, AFRICOM, and CENTCOM are the most likely locations for future competition, confrontation, and conflict between 2030 and 2050

- States will very likely use a mix of military capabilities (e.g., ballistic missiles, cyber, nuclear proliferation) alongside political and economic coercion to deter U.S. military action between 2030 to 2050

- A mix of resource insecurity (e.g., food, water), migration, uneven economic development, and rapid urbanization will lead to pockets of inequality prone to unrest after 2025

- Conflict entrepreneurs are likely to leverage connectivity to mobilize political and ideological opposition between 2020 and 2050
Appendix B: Indications and Warnings

Hypothesis: The interaction of a slowing rate of technological change and its ensuing diffusion, an increasingly competitive multipolar international system, and weakening states will likely lead to increased confrontations between the United States and regional powers and localized unrest and conflicts.

Technology Trends: Chances are even that the rate of technological invention will slow. If so, competitors will likely catch up before the U.S. can leap ahead.

Technology Trend 1:

There is an even chance the rate of technological change will slow in 2030 to 2050, leading to a situation in which it will be cheaper to innovate by integrating existing capabilities than it is to invent new capabilities.

Technology Indicator 1.1:

The correlation of a statistically significant percent change in triadic patents per year and a statistically significant percent change in multifactor productivity per year (measure globally and for major regional actors)

Expected Value: there is no correlation between statistically significant changes in triadic patents and multifactor productivity (integer)

Technology Indicator 1.2:

The correlation of a statistically significant percent change in Business Enterprise Research and Development (BERD) and a statistically significant percent change in multifactor productivity per year (measure globally and for major regional actors)

Expected Value: there is no correlation between statistically significant changes in BERD and multifactor productivity (integer)
Technology Trend 1:

There is an even chance the rate of technological change will slow in 2030 to 2050, leading to a situation in which it will be cheaper to innovate by integrating existing capabilities than it is to invent new capabilities.

Technology Indicator 1.3:

The correlation of a statistically significant percent change in Gross Domestic Expenditure in Research and Development (GERD) and a statistically significant percent change in multifactor productivity per year (measure globally and for major regional actors)

Expected Value: *there is no correlation between statistically significant changes in GERD and multifactor productivity* (integer)

Technology Indicator 1.4

The correlation of a statistically significant percent change in Venture capital (per GDP) and a statistically significant percent change in multifactor productivity per year (measure globally and for major regional actors)

Expected Value: *there is no correlation between statistically significant changes in VC and multifactor productivity* (integer)
Technology Trend 2:
The proliferation of low-cost sensors and their integration into an Internet of Things (IoT) will very likely increase the volume of data and possibility of more refined predictions with economic and battlefield applications after 2020.

Technology Indicator 2.1:
Growth of the IoT market (percent per year, USD)
Expected Value: IoT market continues growing at over 5% per year (integer)

Technology Indicator 2.2:
IoT integrated into military applications enabling prediction
Expected Value: increasing integration

Technology Indicator 2.3:
The correlation of a statistically significant percent change in corporate profits and a statistically significant change in IoT market (measure globally and for major regional actors)
Expected Value: there is a correlation between corporate profits and the growth of the IoT market (integer)
Technology Trend 3:

Increased levels of battlefield autonomy and automated transportation in the commercial sector are increasingly likely after 2025, but the ability of military actors to use them will vary based on policy, legal restrictions, and cultural norms.

Technology Indicator 3.1:

Projected growth of the autonomous transportation market (after 2025) measured in size (USD)

Expected Value: autonomous transportation market is projected to grow in 2025

Technology Indicator 3.2:

Number of legal, domestic and international, and policy restrictions on autonomous transportation

Expected Value: increasing number of restrictions that slow market growth

Technology Indicator 3.3:

Level of autonomous capability projected in military force after 2025 (measure globally and for major regional actors)

Expected Value: increasing autonomy in military after 2025

Technology Indicator 3.4

Number of legal, domestic and legal, and policy restrictions on military autonomy

Expected Value: increasing number of restrictions that slow growth
Technology Trend 4: Systems with Artificial General Intelligence--like capabilities are unlikely before 2040

Technology Indicator 4.1: Median estimate for AGI

Expected Value: survey of 5 estimates for AGI indicate 2040 shows no change in AGI projection (integer)

Technology Indicator 4.2: Mean estimate for AGI

Expected Value: survey of 5 estimates for AGI indicate 2040 shows no change in AGI projection (integer)

Technology Indicator 4.3: Estimated growth in computing power measured in 1) transistors (thousands); 2) single-thread performance (SpecINT); 3) Frequency (MHz); 4) typical power (watts); and 5) number of cores

Expected Value: the growth in computing power is below the historical average (integer)
Technology Trend 5:
Quantum computing is unlikely to reach economies of scale or favorable price points for broad military application before 2030

Technology Indicator 5.1:
Number of firms selling quantum computing applications

Expected Value: the number of firms grows but not significantly

Technology Indicator 5.2:
Percent change in the estimated size of the quantum computing market in 2020-2025

Expected Value: the estimated size of the quantum computing market does not grow significantly before 2030

Technology Indicator 5.3:
Percent change in the price for quantum computing access

Expected Value: the price to buy quantum computing applications should not see significant declines before 2030
Technology Trend 6:
It is almost certain that a larger number of state and non-state actors will have precision strike and advanced C4ISR capabilities by 2020

Technology Indicator 6.1:
Number of state actors able to field precision-fire capabilities (i.e., target, fire with low CEP)
Expected Value: the number grows yearly

Technology Indicator 6.2:
Number of non-state actors able to field improvised precision-fire capabilities (i.e., target, fire with low CEP)
Expected Value: the number grows yearly

International System Trends: A competitive multipolar system will likely increase strategic competition and the resulting risk of miscalculation between regional powers.

International System Trend 1:
A more competitive, multipolar system in which regional powers challenge U.S. interests is likely before 2030

International System Indicator 1.1:
Number of militarized disputes (i.e., confrontations) initiated by regional powers
Expected Value: the number of disputes short of war (i.e., threat, display, limited use of hostility) increases

International System Indicator 1.2:
Number of militarized disputes (i.e., confrontations) involving a regional power
Expected Value: the number of disputes short of war (i.e., threat, display, limited use of hostility) increases
International System Trend 2:
China’s power will very likely rise, and it is the most likely state, other than the United States, with the capability to shape the international system between 2030 and 2050

International System Indicator 1.3:
Number of militarized disputes involving a U.S. ally

Expected Value: the number of disputes short of war (i.e., threat, display, limited use of hostility) involving a U.S. ally increases

International System Indicator 2.1:
Centrality of China in regional political and economic bodies

Expected Value: China initiates more action in regional bodies

International System Indicator 2.2:
Centrality of China in international political and economic bodies

Expected Value: China initiates more action in international bodies

International System Indicator 2.3:
Number of militarized disputes involving China

Expected Value: number of disputes involving China increases
International System Trend 3:
China’s rate of economic growth is likely to continue slowing through 2030

International System Indicator 3.1:
Chinese GDP growth
Expected Value: Chinese GDP growth is less than 7% per year (integer)

International System Indicator 3.2:
Inclusive wealth
Expected Value: yearly change in Chinese inclusive wealth (UN measure) is not increasing above long-term trend (2.0%) (integer)

International System Indicator 3.3:
Power generation
Expected Value: power is not increasing over historical average (growth in generation per year) (integer)

International System Trend 4:
An internal transition in China is unlikely but possible in 2030 to 2050

International System Indicator 4.1:
Reports of party factions
Expected Value: increasing number of vocal party factions

International System Indicator 4.2:
Early elite hedging and defection
Expected Value: reports of party leaders moving assets or buying property overseas
International System Trend 5:
Russia will decline as a state but will very likely continue to challenge the United States between 2030 and 2050 with varying thaws in the relationship

International System Indicator 4.3:
Number of protests
Expected Value: the number of protests (i.e., environmental, economic, political) increases

International System Indicator 5.1:
Russian GDP
Expected Value: Russian GDP declines and/or grows beneath long-term historical average

International System Indicator 5.2:
The correlation of a statistically significant change in oil prices (e.g., Brent) and Russian initiated militarized disputes
Expected Value: as oil prices decrease, Russia initiates fewer disputes (integer)

International System Indicator 5.3:
Russian population growth and composition
Expected Value: Russian population continues to decline and become increasingly less Slavic (integer)
International System Indicator 5.4.
Disputes with U.S. and/or a U.S. ally

Expected Value: the number of disputes between Russia and the U.S./U.S. ally increases (integer)

International System Indicator 5.5.
Dispute initiation

Expected Value: the number of Russian-initiated disputes increases (integer)

Governance Trends: The governance capacity of the state will very likely continue to be challenged from above and below. It will be easy to organize, and unrest will be cheap.

Governance Trend 1:
It is highly likely that networks of international organizations and transnational activists will challenge sovereign authority of states between 2025 and 2050

Governance Indicator 1.1:
Number of significant violent and non-violent protests (yearly)

Expected Value: the number of significant protests (i.e., Arab Spring, Occupy Wall Street, Umbrella Protests) increases each year – note: they do not have to be successful; ideal metric compares to a five-year moving average (integer)
Governance Indicator 1.2:

Number of significant violent and non-violent protests (five-year average)

Expected Value: the number of significant protests (i.e., Arab Spring, Occupy Wall Street, Umbrella Protests) increases during the year over the five-year moving average - note: they do not have to be successful (integer)

Governance Indicator 1.3:

Political terror scale (measure globally and for flash point areas for instability)

Expected Value: the political terror scale increases (integer)

Governance Indicator 1.4:

Political terror scale (five-year average)

(measure globally and for flash point areas for instability)

Expected Value: the political terror scale increases over the five-year average (integer)
Governance Trend 2:
It is highly likely that activists and a range of other interests, from businesses to gangs, will challenge states’ authority, leading to more fragile states that are prone to interstate confrontation and intrastate conflict between 2025 and 2050

Governance Indicator 2.1:
Level of transnational criminal activity
Expected Value: the level of transnational criminal activity sufficient to undermine state authority increases

Governance Indicator 2.2:
Number of safehavens
Expected Value: increasing number of safehavens (both virtual and physical)

Governance Trend 3:
Western Europe, the United States, and East Asia are very likely to see graying populations after 2025, which limit their ability to invest in defense

Governance Indicator 3.1:
Percent of the population over age 65 (measure globally and for identified actors)
Expected Value: there is an increase in the percent of the population over age 65 (integer)

Governance Indicator 3.2:
Defense spending
Expected Value: defense spending (yearly percent change) does not increase over five-year averages (integer)
Governance Trend 4:
There is a likely increase in storms that lead to economic losses and migration after 2025

Governance Indicator 4.1:
Number of superstorms with strategic implications
Expected Value: the number of superstorms that have strategic impacts increases

Governance Indicator 4.2:
Dollar value of storm losses, as measured by insurance payouts and government expenditures in recovery
Expected Value: the yearly increase in storm values is over the previous five-year average (integer)

Governance Indicator 4.3:
Climate migration
Expected Value: the number of climate change--related migrants increases (year)

Governance Trend 5:
Chances are even that climate change will produce economic and migratory challenges in states after 2025

Governance Indicator 5.1:
Level of climate change impact (population)
Expected Value: the number of climate change--linked migrants increases

Governance Indicator 5.2:
Level of climate change impact (resources)
Expected Value: climate change's impact increases
Governance Trend 6:
Localized food and water insecurity is likely to create political grievances after 2025

Governance Indicator 6.1:
An observable relationship between water insecurity (i.e., flooding, drought) and political grievances
Expected Value: increased water insecurity in areas impacted by climate change

Governance Indicator 6.2:
An observable relationship between food insecurity and political grievances
Expected Value: increased food insecurity in areas impacted by climate change

Governance Trend 7:
States will be increasingly fragile; chances are even that a larger, regional actor will collapse between 2025 and 2030

Governance Indicator 7.1:
State failures per year
Expected Value: the number of states at risk of failing increases over the five-year average (integer)

Governance Indicator 7.2:
Signs a regional power might fail
Expected Value: increased elite defections, declining economic activity, and factions
Conflict Trends: The governance capacity of the state will very likely continue to be challenged from above and below. It will be easy to organize, and unrest will be cheap.

Conflict Trend 1:
Increased interstate competition and confrontation and increased intrastate conflict between states is likely in 2025 and 2050

Conflict Indicator 1.1:
Militarized disputes
Expected Value: the number of disputes short of war increases over the five-year average

Conflict Indicator 1.2:
Intrastate conflict
Expected Value: increased intrastate conflict above the five-year average (integer)

Conflict Trend 2:
PACOM, AFRICOM, and CENTCOM are the most likely locations for future competition, confrontation, and conflict between 2030 and 2050

Conflict Indicator 2.1:
PACOM competition, confrontation, and conflict levels
Expected Value: militarized disputes and intrastate war increase in the PACOM AOR over the five-year average (integer)

Conflict Indicator 2.2:
AFRICOM competition, confrontation, and conflict levels
Expected Value: militarized disputes and intrastate war increase in the AFRICOM AOR over the five-year average
Conflict Trend 3:
States will very likely use a mix of military capabilities alongside political and economic coercion to deter U.S. military action between 2030 to 2050

Conflict Indicator 2.3:
CENTCOM competition, confrontation, and conflict levels
Expected Value: militarized disputes and intrastate war increase in the CENTCOM AOR over the five-year average

Conflict Indicator 3.1:
Number of cyber disputes
Expected Value: increased number of cyber disputes above the five-year average (integer)

Conflict Indicator 3.2:
Number of ballistic missiles
Expected Value: increased inventories and diffusion of ballistic missiles in U.S. competitors

Conflict Indicator 3.3:
Nuclear proliferation
Expected Value: increased signs states and/or non-state actors pursuing nuclear weapons

Conflict Indicator 3.4:
Use of coercive diplomacy
Expected Value: increased levels of non-military coercive diplomacy
Conflict Trend 4:
A mix of resource insecurity (e.g., food, water), migration, uneven economic development, and rapid urbanization will lead to pockets of inequality prone to unrest after 2025

Conflict Indicator 4.1:
The correlation of a change in urbanization rates with protests, state fragility, and intrastate conflict
Expected Value: there is a correlation between urbanization and instability (integer)

Conflict Indicator 4.2:
The correlation of migration with protests, state fragility, and intrastate conflict
Expected Value: there is a correlation between migration and instability (integer)

Conflict Indicator 4.3:
The correlation of increasing inequality levels with protests, state fragility, and intrastate conflict
Expected Value: there is a correlation between inequality and instability (integer)

Conflict Trend 5:
Conflict entrepreneurs are likely to leverage connectivity to mobilize political and ideological opposition between 2020 and 2050

Conflict Indicator 5.1:
The correlation of connectivity levels (i.e., ISP numbers, mobile phone usage) in fragile states with increasing levels of protests and intrastate conflict
Expected Value: there is a correlation between connectivity in fragile states and instability (integer)
Appendix C: Glossary

Additive manufacturing: A manufacturing process through which three-dimensional (3D) solid objects are created through the use of a layering development framework in which layers are laid down in succession to complete the object. (Association for Computing Machinery)

Artificial intelligence: The science and engineering of making intelligent machines. (John McCarthy, 1955)

Artificial Narrow Intelligence (ANI): Machine intelligence that equals or exceeds human intelligence or efficiency, but in one specific area. Smartphone apps, spam filters, Google translate and Google search are all examples of ANI. (Singularity Institute Africa)

Artificial General Intelligence (AGI): Refers to a computer that is as smart as a human across the board and that can perform any intellectual task that a human being can. (Singularity Institute Africa)

Artificial Superintelligence (ASI): An intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom, and social skills. Artificial Superintelligence ranges from a computer that’s just a little smarter than a human to one that is trillions of times smarter – across the board. (Nick Bostrom)

Big Data: Extensive datasets – primarily in the characteristics of volume, variety, velocity, and/or variability – that require a scalable architecture for efficient storage, manipulation, and analysis. (National Institute of Standards and Technology)

Biohacking: The activity of exploiting genetic material experimentally without regard to accepted ethical standards, or for criminal purposes. (Oxford Dictionaries)

Bioengineering: Biological or medical application of engineering principles or engineering equipment – called also biomedical engineering; or the application of biological techniques (as genetic recombination) to create modified versions of organisms. (Merriam-Webster Dictionary)

Bridging technologies: Marginal improvements that are measurable without significant impact on combat effectiveness or doctrine. (RDECOM)

Climate change: Any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in
temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. (U.S. Environmental Protection Agency)

**Comparative advantage:** Economic theory posited by David Ricardo in 1817. There is mutual national benefit from trade even if one country is more competitive in every area than its trading counterpart. A nation should concentrate resources only on industries where it had a comparative advantage that is in those industries in which it has the greatest competitive edge. (David Ricardo)

**Competition:** The use of instruments of power: short of direct threats, displays of military force designed to signal an adversary in a crisis, or the limited use of force. For example, a scheduled exercise or use of diplomatic influence represent competition without confrontation. (CSA Strategic Studies Group)

**Confrontation:** The threat, display, or limited use of force short of war. For example, Russia’s intimations on using nuclear weapons (i.e., threats), their increased use of long-range air patrols to signal the U.S. (i.e., display), and Turkish jets shooting down a Russian plane in their air space (i.e., limited use) are all examples of confrontation. (CSA Strategic Studies Group)

**Conflict:** Significant acts of political violence involving the use of force by organized groups, resulting in a significant number of directly related deaths over the course of the episode. For example, the Russo-Georgian War in 2008 (i.e., interstate), the South Sudan Civil War in 2013 (i.e., intrastate), and Russian-backed separatist violence in eastern Ukraine in 2014 (i.e., intrastate with multiple external participants) are examples of conflict. The Uppsala Conflict Data Program places the number of deaths at least 25, while the Integrated Network for Societal Conflict Research (INSCR) indicates at least 500 deaths. (CSA Strategic Studies Group)

**CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats):** The CRISPR system provides a form of acquired immunity. Short segments of foreign DNA, called spacers, are incorporated into the genome between CRISPR repeats, and serve as a “memory” of past exposures. CRISPR spacers are then used to recognize and silence exogenous genetic elements. The technology has been used to functionally inactivate genes in human cell lines and cells, to modify yeasts used to make biofuels, and to genetically modify crop strains. (Sensagent Dictionary)

**Disruptive technologies:** Capabilities so significant that doctrine is reshaped to take full advantage. (RDECOM)
Electronic warfare (EW): Refers to military action involving the use of EM [electro-magnetic] energy and directed energy (DE) to control the EMS [electromagnetic spectrum] or to attack the enemy. (Joint Publication 3-13.1)

Forecast: A view of the FOE that is a product of a person or organization outside of the Strategic Studies Group (SSG). A forecast is a statement of the future - e.g., “in the world of 2030 to 2050, the global environment will be bipolar, characterized by multifaceted competition between the United States and China.” (CSA Strategic Studies Group)

1. Convergence of forecasts: An apparent agreement between two or more forecasts on the realization of a militarily significant estimate of the FOE. For example, if two forecasts predict that in the FOE, China will become a global superpower, the agreement between those forecasts on that estimate is a convergence. (CSA Strategic Studies Group)

2. Divergence of forecasts: An apparent disagreement between two or more forecasts on the realization of a militarily significant estimate of the FOE. For example, if one forecast portends that in the FOE, China will become a global superpower but another forecast disagrees and asserts that China will not escape the middle-income trap, the disagreement between those forecasts on that estimate is a divergence. (CSA Strategic Studies Group)

Future operational environment (FOE): The militarily significant aspects of the global environment in the years 2030 to 2050. The uncertainty, volatility, and complexity of wicked problems. (International Institute for Strategic Studies)

Game-changer: An unexpected low probability event, but if it were to occur, it would have a significant positive impact on the future environment. (CSA Strategic Studies Group)

Genetic engineering: A set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms. The techniques involve sophisticated manipulations of genetic material and other biologically important chemicals. (Union of Concerned Scientists)

G-Zero world: The concept in which no single country or bloc of countries has the political and economic leverage - or will - to drive a truly international agenda. (Ian Bremmer)
**Gray zone**: Coercive and deterrent positioning through kinetic and non-kinetic means short of war – can occur at the level of competition or conflict. (Antulio Echevarria, Army War College Strategic Studies Institute)

**Aging (or graying) population**: A situation in which the ratio of older people (60 years or older) to younger people (15 years or under) is increasing. (United Nations)

**Hedging**: Organizational action intended to better prepare an organization for the failure of one of its important assumptions. A hedging action requires the act of replanning. Defining hedging actions requires rethinking an organization’s plans as though an important assumption had failed, and it ascribes certainty to a failure that is only plausible. (James Dewar, “Assumption-Based Planning,” RAND Corporation, 1993)

**Human enhancement**: Any attempt to temporarily or permanently overcome the current limitations of the human body through natural or artificial means. It is the use of technological means to select or alter human characteristics and capacities, whether or not the alteration results in characteristics and capacities that lie beyond the existing human range. Any method or procedure based on science and technology methods aimed at increasing an individual’s “capability space” beyond current natural abilities. (Institute for Ethics and Emerging Technologies)

**Hybrid conflict**: In overlapping state and non-state violence, there exists an area of conflict where actors blend techniques, capabilities, and resources to achieve their objectives. Such “hybrid” conflicts may consist of military forces assuming a non-state identity, as Russia did in the Crimea, or involve a VEO fielding rudimentary combined arms capabilities, as ISIL has demonstrated in Iraq and Syria. Hybrid conflicts also may be comprised of state and non-state actors working together toward shared objectives, employing a wide range of weapons such as in eastern Ukraine. Hybrid conflicts serve to increase ambiguity, complicate decision-making, and slow the coordination of effective responses. (National Military Strategy, 2015)

**iPSC (induced Pluripotent Stem Cells)**: Adult cells that are genetically reprogrammed into an embryonic-like pluripotent state that enables the development of an unlimited source of any type of human cells needed for therapeutic purposes. (National Institutes of Health)

**Innovation**: The result of critical and creative thinking and the conversion of new ideas into valued outcomes. (Army Operating Concept)
Internet of Things: A system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. (McKinsey & Company)

Leap-ahead technologies: Technologies bringing the combat effectiveness up to the next level but not significant enough to change doctrine. (RDECOM)

Lens: A description of the FOE from the perspective of its actors - both persons and organizations, formal and informal. A lens view captures the future as envisioned by the actors. It is stepping into the shoes of those actors and envisioning the future through their eyes. (CSA Strategic Studies Group)

Machine learning: A method of data analysis that automates analytical model building. Using algorithms that iteratively learn from data, machine learning allows computers to find hidden insights without being explicitly programmed where to look. A form of artificial intelligence that is aimed at creating computing systems that can learn from data. (SAS Institute)

Malthusianism: A school of ideas derived from the political/economic thought of the Reverend Thomas Robert Malthus, as laid out in his 1798 writings, An Essay on the Principle of Population, which describes how unchecked population growth is exponential while the growth of the food supply was expected to be arithmetical. (Thomas Malthus)

Megacities: Dense, urban agglomerations with a population of 10 million or more. (United Nations)

Militarily significant: A fact that, in light of best military judgment, would be significant to the U.S. Army, as an enterprise, in resourcing, planning, and conducting operations in the FOE. (CSA Strategic Studies Group)

“One Belt, One Road”: “Silk Road Economic Belt” and “21st Century Maritime Silk Road,” often referred to jointly as the “One Belt, One Road,” is a planned network of overland road and rail routes, oil and natural gas pipelines, and other infrastructure projects that will stretch from Xi’an in central China, through Central Asia, and ultimately reach as far as Moscow, Rotterdam, and Venice. (Center for Strategic & International Studies)

Sensors: Sophisticated devices that are designed to detect events or changes in their environment, measure and record physical phenomena, and to respond by transmitting information, initiating changes, or operating controls with a corre-
sponding output. Lately, sensors have expanded in their capacity to connect and interact with other devices, and primary examples are smartphones, tablets, and computers. (Webster’s New World Dictionary)

**Shaping:** An organizational action designed either to avert or cause the failure of a vulnerable assumption. This entails deciding whether a potential change in the assumption is for the better or the worse, identifying the extent to which the organization has control over the assumption and defining actions to exert that control. (James Dewar, “Assumption-Based Planning,” RAND Corporation, 1993)

**Shocks:** An unexpected low probability event, but if it were to occur, it would have a significant negative impact on the future environment. (CSA Strategic Studies Group)

**Smart cities:** An urban development vision to integrate multiple information and communication technology solutions in a secure fashion to manage a city’s assets. The goal of building a smart city is to improve quality of life by using technology to improve the efficiency of services and meet residents’ needs. (Urban Institute)

**Supra-national Organizations:** A multinational political union where negotiated power is delegated to an authority by governments of member states. The concept of supra-national union is sometimes used to describe the European Union, as a new type of political entity. (CSA Strategic Studies Group)

**Synthetic biology:** An emerging area of research that can broadly be described as the design and construction of novel artificial biological pathways, organisms or devices, or the redesign of existing natural biological systems. (United Kingdom Royal Society)

**Trend:** A pattern of gradual change in a condition, output, or process, or an average or general tendency of a series of data points to move in a certain direction over time. A trend is an emerging pattern of change likely to impact the environment, thereby requiring a response (i.e., adult children taking care of parents). (CSA Strategic Studies Group)

**Wildcard:** An unexpected low probability event, but if it were to occur, it would have a significant impact on the future environment. (Edward Cornish, Futuring: The Exploration of the Future, 2004)

**Youth Bulge:** A phenomenon in which a large share of a state’s population is comprised of children and young adults aged 15 to 24 years of age. (United Nations)
## Appendix D: Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIIB</td>
<td>Asian Infrastructure Investment Bank</td>
</tr>
<tr>
<td>A2/AD</td>
<td>Anti-Access/Area Denial</td>
</tr>
<tr>
<td>AF</td>
<td>Afghanistan</td>
</tr>
<tr>
<td>AS</td>
<td>Autonomous System</td>
</tr>
<tr>
<td>ASpIRE</td>
<td>Automatic Speech Recognition in Reverberant Environments</td>
</tr>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>CAM</td>
<td>Combined Arms and Maneuver</td>
</tr>
<tr>
<td>CCP</td>
<td>Chinese Communist Party</td>
</tr>
<tr>
<td>CPEC</td>
<td>China-Pakistan Economic Corridor</td>
</tr>
<tr>
<td>CSA</td>
<td>Chief of Staff of the Army</td>
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<tr>
<td>CSA SSG</td>
<td>Chief of Staff of the Army Strategic Studies Group</td>
</tr>
<tr>
<td>CSIS</td>
<td>Center for Strategic and International Studies</td>
</tr>
<tr>
<td>DIME</td>
<td>Diplomatic Information Military Economics</td>
</tr>
<tr>
<td>DOD</td>
<td>Department of Defense</td>
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<tr>
<td>DPRK</td>
<td>Democratic People’s Republic of Korea</td>
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<tr>
<td>DSCA</td>
<td>Defense Security Cooperation Agency</td>
</tr>
<tr>
<td>EEU</td>
<td>Eurasian Economic Union</td>
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<tr>
<td>EEZ</td>
<td>Exclusive Economic Zone</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>EW</td>
<td>Electronic Warfare</td>
</tr>
<tr>
<td>FOE</td>
<td>Future Operations Environment</td>
</tr>
<tr>
<td>G-20</td>
<td>Group of Twenty</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GLN</td>
<td>Global Landpower Network</td>
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<tr>
<td>GMLRS</td>
<td>Guided-Multiple Launch Rocket System</td>
</tr>
<tr>
<td>IARPA</td>
<td>Intelligence Advanced Research Projects Agency</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>iPSC</td>
<td>induced Pluripotent Stem Cells</td>
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<tr>
<td>ISR</td>
<td>Intelligence, Surveillance, and Reconnaissance</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>IWO</td>
<td>International World Order</td>
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<tr>
<td>LA</td>
<td>Latin America</td>
</tr>
<tr>
<td>LRBM</td>
<td>Long Range Ballistic Missile</td>
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<tr>
<td>ME</td>
<td>Middle East</td>
</tr>
<tr>
<td>MRBM</td>
<td>Medium Range Ballistic Missile</td>
</tr>
<tr>
<td>NATO</td>
<td>North Atlantic Treaty Organization</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>NCO</td>
<td>Noncommissioned Officer</td>
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<tr>
<td>NEO</td>
<td>Noncombatant Evacuation Operation</td>
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<tr>
<td>NIC</td>
<td>National Intelligence Council</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>PLA</td>
<td>People's Liberation Army</td>
</tr>
<tr>
<td>PMESII</td>
<td>Political, Military, Economic, Social, Infrastructure, and Information Systems</td>
</tr>
<tr>
<td>POD</td>
<td>Point of Departure</td>
</tr>
<tr>
<td>POM</td>
<td>Program Objective Memorandum</td>
</tr>
<tr>
<td>PRC</td>
<td>People's Republic of China</td>
</tr>
<tr>
<td>RDECOM</td>
<td>Research Development and Engineering Command</td>
</tr>
<tr>
<td>SAM</td>
<td>Surface-to-Air Missile</td>
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<tr>
<td>SCO</td>
<td>Strategic Capabilities Office</td>
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<tr>
<td>SCO</td>
<td>Shanghai Cooperation Organization</td>
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<tr>
<td>TCO</td>
<td>Transnational Criminal Organization</td>
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<tr>
<td>TPP</td>
<td>Trans-Pacific Partnership</td>
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<tr>
<td>TRADOC</td>
<td>U.S. Army Training and Doctrine Command</td>
</tr>
<tr>
<td>TTCSP</td>
<td>Think Tanks and Civil Societies Program</td>
</tr>
<tr>
<td>UARC</td>
<td>University Affiliated Research Center</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
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<tr>
<td>U.N.</td>
<td>United Nations</td>
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<tr>
<td>USARPAC</td>
<td>U.S. Army Pacific</td>
</tr>
<tr>
<td>USG</td>
<td>United States Government</td>
</tr>
<tr>
<td>VBA</td>
<td>Visual Basic for Applications</td>
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<tr>
<td>VEO</td>
<td>Violent Extremist Organization</td>
</tr>
<tr>
<td>WAS</td>
<td>Wide-Area Security</td>
</tr>
<tr>
<td>WMD</td>
<td>Weapons of Mass Destruction</td>
</tr>
</tbody>
</table>
Endnotes


2. Specifically, the SSG’s database has 1,044 sources and 8,242 data entries that are aggregated and concatenated into 5,242 unique lens-source-question-categorical-answer combinations. Sources: Published documents; key/senior leader engagements, interviews, testimony, and speeches. Observations: Aggregate number of data records entered in the SSG database. Combinations: How the source perceives the future, viewed through a particular lens, pursuant to one of 13 research questions, with responses binned by categorical answer. For the purpose of the pie charts in this report, combinations serve as the data points upon which the percentages are based.

3. 4+1 refers to Russia, China, Iran, North Korea, and violent extremist organizations or transnational criminal organizations.

4. Essentially, the planning fallacy is the tendency to “describe plans and forecasts that . . . are unrealistically close to the best-case scenarios [and that] could be improved by consulting the statistics of similar cases,” while the hindsight bias is the tendency to see a contingent event as inevitable. Daniel Kahneman, *Thinking Fast and Slow* (New York: Farrar, Straus, and Giroux, 2011), Kindle, 201-202, 249-250.


8. The First Industrial Revolution was harnessing steam power to “mechanize production”; the Second Industrial Revolution was the use of electric power to “create mass production”; and the Third Industrial Revolution was the use of information technology to, at least to a degree, “automate production.” World Economic Forum, “The Fourth Industrial Revolution: What It Means and How to Respond,” by Klaus Schwab (Switzerland: World Economic Forum, 2016), 9, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond.

9. Data gleaned from all lenses was queried to identify how many of the sources employed in the analysis answered “technology,” “cyber,” or “information” to one or more of the research questions. The specific words and phrases the source used in each of the data entries were then reviewed to identify how many of the sources addressed the specific areas detailed in the chart. Converting all words to lowercase, employing singular forms of each word and phrase, and using all punctuation combinations allowing capturing all applicable words regardless of case and punctuation marks, including plurals. For the word search, mapping of words to technological area was: *Additive man-
ufacturing (3D printing): 3 d, 3d, 3-d, 4 d, 4d, 4-d, additive manufacturing; Artificial intelligence: a.i., agi, a.g.i., ai, artificial general intelligence, artificial general intelligences, artificial intelligence, artificial intelligences, artificial super intelligence, artificial super intelligences, asi, a.s.i.; Autonomous machines or robotics: autonomous, autonomously, autonomy, pilotless, robot, robotic, robotics, robots, self drive, self driving, selfdrive, self-drive, self-driving, semi autonomous, semi autonomously, semiautonomous, semi-autonomous, semi-autonomously, soldier machine, soldier/machine, soldier-machine; Ballistic missile: ballistic missile. Big data: big data; Biotechnology: bio, bio hacking, bio tech, bio-hacking, bio-tech, biotechnologies, bio-technologies, biotechnology, bio-technology, chromosomes, crispr, crispr/cas9, deoxyribonucleic, DNA, gene, genes, genetic, genetics, genome, genomes, genomics, human assisted, human enhancement, ribonucleic, RNA; Connectivity, global information grid, communications: communicate, communicating, communication, communications, connect, connected, connectedness, connecting, connection, connections, connectivity, connects, global grid, global information grid; Cyber: cyber, cyber space, cyberattack, cyber-attack, cybersecurity, cyber-security, cyberspace, cyber-space, hacking, internet, iot, i.o.t.; Directed energy & hypersonics: directed energy, hyper sonic, hyper velocity, hypersonic, hyper-sonic, hypervelocity, hyper-velocity, lase, laser, laser-based, laser-based, lasered, lasers; Nuclear proliferation: nuclear proliferation; Quantum computing: qbit, qbits, quantum, qubit, qubits; Sensors and their proliferation: sensor, sensors; Space and counter space: anti satellite, anti satellites, antisatellite, anti-satellite, antisatellites, anti-satellites, counter space, counterspace, counter-space, orbit, orbits, Outer space, Outerspace, Outer-space, satellite, satellites, space, space-based.


11. Interview with confidential source (SID 881), New York, March 1, 2016.


15. Interview with confidential source (SID 684), Austin, TX, February 11, 2016.


20. Interview with confidential source (SID 681), Austin, TX, February 10, 2016; interview with confidential source (SID 671), Tampa, FL, February 9, 2016; telephone interviews with confidential sources (SID 813), February 3, 2016.


24. Interview with confidential source (SID 781), Hanover, NH, February 21, 2016.


27. Interview with confidential source (SID 787), San Francisco, CA, February 22, 2016.


29. Further, an assessment of any breakthrough technology’s cost should include the costs of failed attempts to develop other technologies.

31. Sources were asked: “What are the resulting concepts for the international order in 2030-2040 – Unipolar, Bipolar, Multipolar, Erosion of Order, or Other?” 50% answered multipolar, 34% erosion of order, 3% bipolar, 6% unipolar, and 7% offered a different concept. Most of the sources that answered “erosion of order” cited that there would be a diffusion of power from supra-national organizations like the United Nations to regional powers and a diffusion of power from nation-states to non-states actors such as mega corporations, megacities, transnational criminal organizations (TCOs), and super-empowered individuals.


35. Part of the study was to run a word frequency count within the database. “China” was the most frequently cited word, “United States” was mentioned second most, and “state” was mentioned third most.

36. Manning, Envisioning 2030, 34.

37. For the minority view arguing China will not be a stronger competitor in the future, see interview with confidential source (SID 557), Chicago, IL, January 20, 2016; Friedman, The Next 100 Years, 6; interview with confidential source (SID 631), Washington, DC, February 4, 2016.


39. Also not surprisingly, the source of the quote about China wanting to “blend with the existing world and international order” came from a Chinese author. The full quote is: “China does not want to build a separate world hostile to America; it wants to blend with the existing world and international order.” See Liu Mingfu, The China Dream: Great Power Thinking and Strategic Posture in the Post-American Era (New York: Beijing Mediatime Books, 2015), 51.


43. Interview with confidential source (SID 216), Arlington, VA, December 7, 2015.


48. Interview with confidential source (SID 873), New York, March 9, 2016; interview with confidential source (SID 960), Taipei, Taiwan, March 8, 2016.


50. Telephone interview with confidential source (SID 143), January 8, 2016.

51. Survey responses from confidential source (SID 401), Tokyo, January 14, 2016.

52. Sources in all four lenses agree that this is likely to be so. See The National Intelligence Council, Global Trends 2030, iv; KPMG International, Investing in the Future: How Megatrends Are Reshaping...


54. This conclusion is also discussed in a paper published by the Atlantic Council. See Manning, Envisioning 2030, 20.


The Character of Warfare 2030 to 2050


67. Training and Doctrine Command (TRADOC) G-2, Operational Environments to 2028, 24-25.


70. Valdes and Foster, Net-Food Importing Developing Countries.


77. Interview with confidential source (SID 757), New York, March 1, 2016.

78. Roundtable discussion with confidential sources (SID 830), Honolulu, HI, March 15, 2016.

79. Interview with confidential source (SID 524), Washington, DC, February 2, 2016.

80. Interview with confidential source (SID 799), Washington, DC, January 12, 2016.

81. Michael Green, Kathleen Hicks, and Mark Cancian, Asia-Pacific Rebalance 2025: Capabilities, Presence, and Partnerships (Washington, DC: Center for Strategic & International Studies, 2016),
Technological Change, the International System, and the State


83. DeRochie, “The Driving Factor,” 3; Green, Hicks, and Cancian, Asia-Pacific Rebalance 2025, 23.

84. Lankov, The Real North Korea, 190; Kaplan and Denmark, "The Long Goodbye.”

85. Telephone interview with confidential source (SID 143), Washington, D.C., January 8, 2016.

86. One U.S. source stated, “a Chinese leadership bent on wielding its strength will expect North Korea to accept its position as Beijing’s client. Given North Korean leader Kim Jong-un’s apparent penchant to turn toward provocations when he judges he is being ignored, Beijing’s more dismissive approach could inadvertently contribute to rising strain on the peninsula.” See Green, Hicks, and Cancian, Asia-Pacific Rebalance 2025, 15.

87. Interview with confidential sources (SID 666), Tampa, FL, February 9, 2016. Both the competitor and allies lenses contain sources discussing the House of Saud’s collapse. See “The Future International Order”; interview with Combined Strategic Analysis Group (CSAG), Tampa, FL, February 11, 2016. Interestingly, none of the sources postulated that the fall could be the consequence of the breakdown of the implicit bargain among the royal family and the Wahhabis, perhaps predicated by an economic crisis.

88. A sudden collapse of North Korea could prompt significant migration from that country. Even if the collapse were not sudden, it is likely that the North Korean border control would be severely weakened, and much like East Germans at the end of the Cold War, it should be expected that North Koreans will attempt to leave the country. In either event, the migration flow could be significant.

89. “A collapse of the North Korean government, whether due to South Korean military action or otherwise, would derail PLA modernization efforts and draw it into a COIN-type conflict to prevent expansion of South Korean/U.S. influence on its border.” Telephone interview with confidential source (SID 143), Washington, D.C., January 8, 2016.

90. Interview with confidential source (SID 947), March 2, 2016.


92. von Clausewitz, On War, 75.

93. Interview with confidential source (SID 557), Chicago, IL, Austin, TX, January 20, 2016.
94. Interview with confidential sources (SID 850), Austin, TX, February 10, 2016.


96. Interview with confidential sources (SID 664), Washington, DC, February 4, 2016.

97. Mary Ellen Connell and Ryan Evans (rapporteurs), Russia’s “Ambiguous Warfare” and Implications for the U.S. Marine Corps (Arlington: Center for Naval Analysis, 2015), 5.

98. For overview of the evolution of Iranian ground tactics along these lines, see Marc Lindemann, “The 2006 Lebanon War and the Evolution of Iranian Ground Tactics,” Military Review 90, no. 3 (May/June 2010).

99. Interview with confidential sources (SID 664), Washington, DC, February 4, 2016; also see Chief of Staff of the Army’s Strategic Studies Group, Megacities Concept Team, Megacities and the United States Army: Preparing for a Complex and Uncertain Future (Arlington, VA: Chief of Staff of the Army, June 2014).

100. Roundtable discussion with confidential sources (SID 910), Singapore, March 11, 2016; roundtable discussion with confidential sources (SID 830), Honolulu, HI, March 15, 2016.


103. As noted in the box “U.S. Impacts,” there should be no assumption that the U.S. is immune from these pressures. But the SSG did not identify any organization in the U.S. government that is responsible for potential implications of these futures for domestic U.S. security. Clearly, any threat to the homeland will probably require action by the U.S. Army.

