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Nuclear Security Futures Scenarios

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Abstract

This report provides an overview of the scenarios used in strategic futures workshops conducted at Sandia on September 21 and 29, 2016. The workshops, designed and facilitated by analysts in Center 100, used scenarios to enable thought leaders to think collectively about the changing aspects of global nuclear security and the potential implications for the US Government and Sandia National Laboratories.

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CONTENT

FIGURES

1 INTRODUCTION

A forward looking leadership team at Sandia National Laboratories (SNL) convened two strategic futures workshops on September 21 and 29, 2016. The workshops, designed and facilitated by Center 100 Executive Strategy Development & Decision Support, used scenarios to enable thought leaders to think collectively about the changing aspects of global nuclear security and the potential implications for the US Government and Sandia National Laboratories (SNL).

Workshop participants were asked to validate and apply the scenarios by working together to answer the following questions:

- Scenario Validation
    - What are some of the other characteristics you might use to describe this scenario?
    - What are some of the other headlines you might see in this scenario environment?

- Scenario Application
    - What will it take for the United States Government (USG) to confidently anticipate, assess and address nuclear risks worldwide in this scenario?
    - What are the implications for various program areas in this scenario?
        - Civilian Nuclear Fuel Cycle Safety, Security and Safeguards
        - Defense Nuclear Enterprise, Safety and Secuirty
        - Nonproliferation and Arms Control
        - Counterproliferation and Response
    - What are the implications for various cross-cutting enablers in this scenario?
        - Anticipatory Intelligence
        - Situational Awareness
        - Systems Risk Models
    - How will SNL know if the environment is changing? What role, if any, can SNL play in preventing or enabling a move from one scenario to another?

This report captures the scenario content and read-ahead material used to facilitate the workshops. Section 2 provides the global nuclear security scenarios developed for the workshop. Appendix A describes the scenario development process. Appendix B includes the read-ahead materials shared with workshop attendees.

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2 SCENARIOS

Prior to the first workshop, participants were presented with background reading on what global security might look like in 2035[1] and four global nuclear security scenarios for consideration (Figure 1).

The scenarios were developed by the Strategic Futures team in Org. 159 Policy & Decision Analytics based on a literature review and interviews with, and input from, experts and creative thinkers within and beyond SNL.[2] Each scenario included a brief description and sample news story.

Figure 1. 2035 Scenarios

[1] For the Global Trends Article Excerpts, see Appendix B

[2] For more on the scenario development process see Appendix A

Scenario 1: Next Challenge, Please

Scenario Description

It is 2035 and we live in a world marked by low proliferation of nuclear weapons and high confidence in international agreements and institutions.

- Nuclear energy (NE) is widespread, but multilateral fuel banks have reduced the number of enrichment facilities worldwide. The fuel banks reflect a Nuclear Nonproliferation Treaty (NPT) reinvigorated by the verification of reduced stockpiles in the US, Russia and China and the symbolic transfer of nuclear modernization budgets into the Global Fund for Disaster Preparedness and Response.
- Rogue state and non-state actors remain interested in the acquisition of nuclear weapons, but cyber and bioweapons have become more attractive due to the cost, accessibility and impact.
- Overall, nuclear issues recede into the background as other threats (cyber, bio, and climate) demand global attention. Decreased funding and strategic attention pose challenges for avoiding complacency about continued nuclear risks.
- The US is still a critical player, but not the dominant leader, in shaping international rules and agreements. Emerging powers and non-state actors (including corporations and foundations) play a much larger role.

Sample Headline/News Story

FUEL BANK EXPLOSION DELAYS H12N9 SUMMIT_____

(May 15, 2035, Singapore, Singapore) The explosion early yesterday morning at Singapore's Multilateral Fuel Bank has caused global leaders to postpone the global H12N9 Summit scheduled for Singapore this week.

Officials have released few details on the attack, but have noted that the explosion appears to have been generated by an insider attack. The perpetrators are believed to be a husband and wife team, who have worked at the bank since it was established 12 years ago. The husband worked in materials safety and the wife led a team in cyber safeguards for the bank.

Motivations remain unclear. One prominent blogger has speculated that the damage may be the result of disgruntled employees, while a source close to the investigation suggests that the couple may have been communicating through NextAp with members of the transnational terrorist network XYZ. No statement has been issued taking credit for the event. The three other multilateral fuel banks, in Brazil, Kazakhstan and South Africa, have all been placed on high alert.

The attack comes as Singapore was preparing to host world leaders from countries, companies and global networks to develop a coordinated response to the H12N9 epidemic that has devastated regions in North Asia and continues to spread worldwide. Officials have postponed the summit to allow emergency responders and security teams in Singapore to focus on incident response. Given the severity of the epidemic and growing urgency for coordinated response, the summit will likely take place in Sydney, Australia next week.

Scenario 2: Crisis-Induced Cooperation

Scenario Description

It is 2035 and we live in a world marked by high proliferation of nuclear weapons and high confidence in international agreements and institutions.

- Following severe accidental detonation, countries rally quickly with cooperation commitments, but the details of arms reductions and verification take time to negotiate as most nuclear weapon countries look to reduce, but not eliminate, their stockpile.
- Multiple countries with varying security cultures and capabilities look to the US for guidance and assistance in disarmament.
- Rogue states and non-state actors seek to exploit the transition to gain access to materials, expertise and weapons.
- Activist communities in multiple countries create global network demanding nuclear disarmament.
- Risk of additional accidents remains high.

Sample Headline/Story

Nuclear Security Summit Marks Fifth Anniversary of Jammu Disaster[3]_____

(February 17, 2035, Karachi, Pakistan) World leaders convene today in Delhi to mark the five-year anniversary of the nuclear accident that rocked the world. The summit is designed to review progress on communication protocols, safety and security collaboration and disarmament commitments.

Five years ago today, the explosion destroyed Jammu, the capital city of Kashmir and nearly set off a heated exchange between India and Pakistan. The disaster, which remains the most heavily documented historical event in history, killed an estimate 400,000 people in the initial explosion and more than 20,000 in subsequent days due to panicked evacuations and riots. India's Ministry of Health and Family Welfare estimates there are roughly one million survivors with physical injuries from the blast and countless more suffering with psychological impacts.

The official International Atomic Energy Agency (IAEA) incident report blames the explosion on the failure of safety hardware during transport and credits decades of communication-building between India and Pakistan, and coordinated diplomatic intervention by the United States, Russia and China, for avoiding a catastrophic war between the neighboring countries.

Over the course of this week, the state and non-state actors gathered in Delhi will review progress on the communication protocols put in place in 2031 and review progress on the safety and security collaboration. The most challenging piece of the summit will be the disarmament negotiations initiated in 2034. Thus far, three countries have already eliminated their nuclear weapons programs and three more are committed to complete disarmament. The other 11 have committed to significant reductions, but targets and timelines remain vague.

Protesters pushing for accelerated disarmament have gathered in Delhi and in capitals around the world to honor the victims of the Jammu disaster and demand quicker and bolder action.

[3] The inspiration for this scenario is drawn from a similar scenario that appears in in NSquare's Crossroads.

Scenario 3: Shifting Sands

Scenario Description

It is 2035 and we live in a world marked by low proliferation of nuclear weapons and low confidence in international agreements and institutions.

- Nuclear weapons states jockey for alliances as the credibility of US security commitments are questioned.
- As NPT dissolves, threshold states debate whether new alliances or Nuclear Weapons (NW) programs will provide benefits that exceed the costs.
- Widespread nuclear energy contributes to latent NW capability worldwide.
- Powerful states attempt to control proliferation with military force leading to regional instabilities.
- Countries that have nuclear weapons continue to focus on deterrence, though policy has not kept pace with the changing geopolitical dynamics (e.g., multitude of players, dynamism of alliances and escalating arms race).

Sample Headline/Story

US Attempts to Reassure Allies with Weapons Deployment_____

(November 9, 2035, Washington, D.C.) Following yesterday's underground nuclear detonation by the Islamic State, the US has reiterated its commitment to working with allies in the region to "make Raqqa understand the costs of its provocations." Security experts expect the US will continue to leverage a range of mechanisms against the Islamic State, including economic and cyber tools, to demonstrate commitment to allies in the region.

Bloggers citing Leakapedia also anticipate the US will seek to deter further aggression by the Islamic State and maintain alliances with Saudi Arabia and Egypt by shifting some number of nuclear weapons to the region. The hope is to maintain stability while reassuring allies that they do not need to develop their own weapons programs. US talks with Iran on the broader regional implications of the arrangement are ongoing.

It remains unclear which countries would be receptive to hosting US nuclear weapons, and whether the US would want to concentrate the weapons in one area or spread them in a perimeter around the Islamic State. Nearly surrounded by the Islamic State, positioning weapons in Saudi Arabia would send a loud message, but could potentially create a backlash against the monarchy. Countries on the fringes on the Islamic State, such as Andalusia and South Nigeria, would be more receptive, but are further from Raqqa. Even further afield, the Philippines has asked for a greater US presence in deterring Islamic State's expansion, but Chinese opposition could rule out that option.

Top security advisors are divided on the redeployment approach. While some urge redeployment as a critical step for maintaining allies in the region, there is also a strong reluctance from many who question the security readiness and manpower availability for this type of mission.

Scenario 4: On the Brink

Scenario Description

It is 2035 and we live in a world marked by high proliferation of nuclear weapons and low confidence in international agreements and institutions. Reports indicate that two neighboring South American powers have tested nuclear weapons this year.

- Nuclear weapons are now a tool in the toolkit of many countries. Heavy proliferation and the advancement of tools leads to increased tactical use and a global black market for NW.
- Full-scale interstate wars become rare, but devastating.
- High risk of safety and security incidents; lack of cooperation reduces resilience.
- Lack of access and communication places emphasis on unilateral monitoring and incident response.

Sample Headline/Story

PLUTONIUM DETECTED IN PARAGUAY EXPLOSION_____

(January 11, 2035, Asuncion, Paraguay) Officials in Asunción confirmed today that trace amounts of plutonium were detected following the January 4th explosion that leveled a garage in the upscale Villa Morra neighborhood of Paraguay's capital city. In the days following the bombing, social media postings from scientists from the Universidad Nacional de Asunción have fueled rumors that radioactive materials were scattered in the explosion.

Nuclear analysts have speculated that the presence of plutonium would be a strong indicator that the warehouse was being used to smuggle nuclear materials, and possibly nuclear weapons, through Paraguay. Over the past several years, the US administration has publicly encouraged Paraguay to contain the sophisticated drug, weapon, and human smuggling operations that have been concentrating in Ciudad del Este, a city long known for its ties to smuggling across its border with Brazil and neighboring Argentina. US pleas for cooperation have usually been ignored, and occasionally rebuked by Paraguayan officials.

Earlier in the week, officials in Asunción confirmed that the destroyed property was under an ongoing antiterrorism investigation for its role in a network to smuggle arms to Africa. Officials accused "outside powers" of causing the explosion and disrupting their investigation. In comments today, the official blamed the unnamed "outside powers" for the plutonium dispersal, which they say could potentially put at risk the health of its citizens.

The official refused to pin blame for the dispersal on Brazil and Argentina, the two new South American nuclear powers whose programs seemed the most likely source of the plutonium. "With the rapid increase in nuclear armed countries over the past several years, there are many potential sources that we will investigate," the official explained. The official alleged that this misplaced blame arose from "neocolonialist ambitions" angry at South America for developing its own nuclear capabilities.

Although Paraguay refuses to blame Brazil or Argentina, well-placed sources in both countries are accusing each other of cooperating with terrorist smuggling networks. The undercurrent of blame underscores a growing schism between Brasilia and Buenos Aires since the initial demonstration last year of their co-developed nuclear weapon in an undersea test off the Argentine coast in July of last year.

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APPENDIX A: SCENARIO DEVELOPMENT PROCESS

The scenarios used in the Strategic Foresight Workshops were developed by the Strategic Futures team in Org. 159 using a classic five-step scenario creation process as seen in Figure 6.

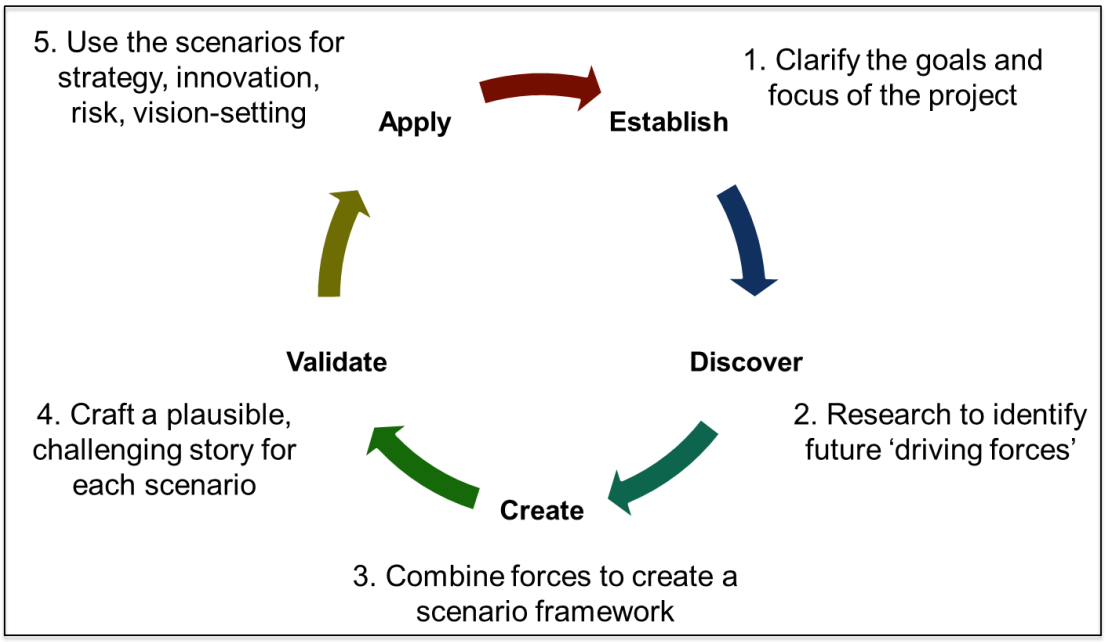

Figure 2. Scenario Creation Process

Phase 1: Establish

The team identified the strategic challenge and framing questions based on the current Sandia leadership thinking and feedback from the external consultants.

- **Strategic Challenge:** How can Sandia better lead the nation in enabling the US Government to confidently anticipate, assess, and address nuclear risks worldwide?

- **Framing Questions:** What is the future of global nuclear assurance and security?
  - What might global nuclear risks look like in 2035?
  - What does this mean for national security?
  - What does it mean for SNL?
  - What actions should we take now?

Phase 2: Discover

The Strategic Futures team researched the driving forces shaping the future of global nuclear assurance security through a literature review[4] and interviews with, and input from, diverse experts and creative thinkers within and beyond SNL.

[4] The literature reviewed was of three primary types: broad analyses of global future trends; strategic, externally published literature on topics specific to nuclear security; and literature published internally at Sandia on topics specific to nuclear security.

The interviewees were identified through a modified snowball process, starting with interested Sandia directors and the external consultants, who identified additional persons for the interview process. In addition, external experts with recent and relevant publications were contacted through in-person or telephone interviews. Each interview lasted between 30 minutes and one hour, and involved two members of the strategic futures team. Interviewees were notified that while their names would be shared as participants in the discovery process, responses would not be attributed to any particular individual.

Interviewees were asked five questions:

1. What, in your view, are the most significant and uncertain driving forces affecting the future of global nuclear risk and security?
2. What type of blindsiding technological, policy or geopolitical developments might undermine the current focus of nuclear security?
3. Can you give a detailed sense of how a good and bad scenario might evolve for nuclear security in the next decade?
4. (Directors) In your view, what are the one or two critical strategic decisions on the immediate horizon?
   (Non-Directors) As you think about the future of Sandia and our work on global nuclear security, what keeps you awake at night? What do you most hope for?
5. Who else should the interviewers be talking to? Are there other SMEs, thought leaders or creative thinkers within and beyond Sandia the interviewers should reach out to for input?

Phase 3: Create

Drawing on analysis of both interviews and literature, the strategic futures team worked together to:

- Compile a list of key risks identified as having the potential to affect nuclear security in the future, driving forces for those risks, uncertainties in those driving forces and potential outcomes (good and bad scenarios named by the respondents).[5]
- Identify and prioritize common themes in the risks, driving forces, and critical uncertainties. A critical uncertainty underlies a continuum of plausible outcomes for a driving force, where there is both a high level of uncertainty and high impact (Figure 7). Wild cards are those events at the most extreme end of both uncertainty and impact. Examples of critical uncertainties identified in this manner are:
    - Public Trust in Government
    - Effectiveness and Extent of International Cooperation and Institutions
    - Strength of Nuclear Taboo (willingness to detonate nuclear weapons or radiological device)
    - US Engagement in Global Security
    - Security Culture (e.g., existence and awareness of, capacity for, and adherence to security procedures)

[5] Nuclear security risks were characterized according to assets that might be threatened (e.g., materials, facilities, devices, institutions and/or regimes); driving forces were characterized according to whether they were primarily geopolitical, social, economic, or technical; scenarios were characterized by threats to assets, pathways for realizing the threats, triggering events and consequences. Not all interview responses were amenable to this characterization ontology developed a priori. In these cases, the team captured the essence of the interview narrative, rather than try to force fit into the ontology.

- Type of Actors with Power and Control (system dominated by state vs. non-state actors)

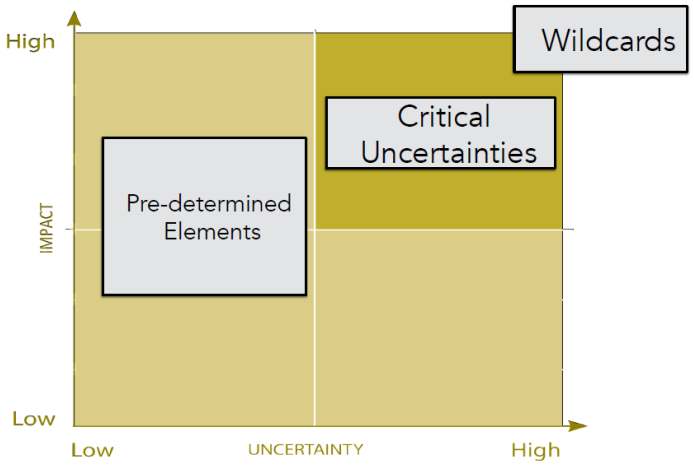

Figure 3. Identifying critical uncertainties and wild cards critical uncertainties considered

- Create preliminary scenario matrices by using the critical uncertainties identified in different combinations as horizontal and vertical axes (Figure 8).

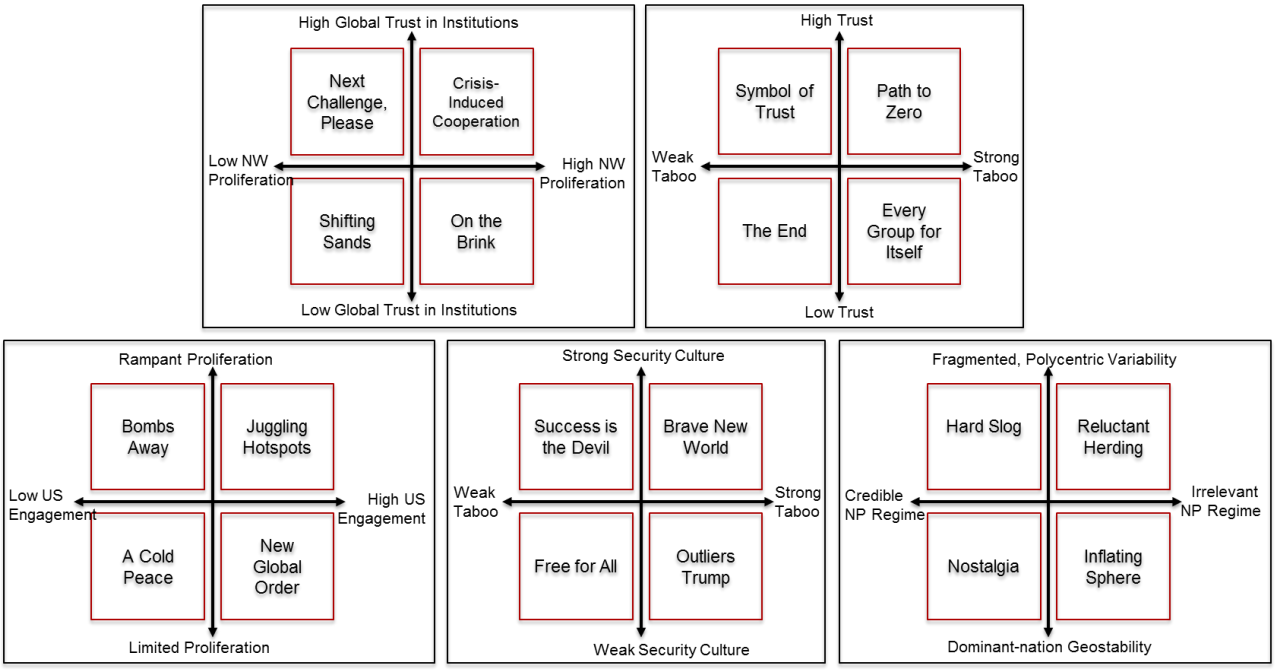

Figure 4. Sample of matrices developed with different critical uncertainty axes

- Test the scenario matrices against the criteria for good scenarios
  - **Challenging** to today's conventional wisdom, not just variations on the same theme
  - **Divergent.** Together the scenarios stretch thinking in different directions

    - **Plausible.** Each scenario could actually happen in some form or in some segment of the market
    - **Balanced.** Strike a good psychological balance between positive and negative stories (at first glance)
    - **Relevant** to the key strategic challenges at hand
- Select the matrix of scenarios best suited for the objectives of the workshops
- Refine the description of each scenario and develop a sample news story that highlights potential challenges for a mitigation approach using input from peer reviewers.

Phase 4: Validate
Workshop 1 participants participated in the validation of the selected scenarios by considering what other characteristics and headlines might be relevant for each scenario (see Section 3).

Phase 5: Apply
The scenarios were applied over the course of both workshops as participants considered the implications for the USG and SNL (see Section 3).

APPENDIX B. GLOBAL TRENDS ARTICLE EXCERPTS

Global Trends Article Excerpts
This packet includes brief summaries of three recent global trends reports, which will help lay the foundation for thinking collectively about what global nuclear risk and security might look like in 2035.

1. **US Joint Chiefs of Staff. 2016. "Joint Operating Environment 2035: The Joint Force in a Contested and Disordered World." Department of Defense. Defense Technical Information Center. July 14.**
   http://www.dtic.mil/doctrine/concepts/joe/joe_2035_july16.pdf
   Excerpt includes pieces of the executive summary and a condensed version of global trends and drivers

2. **National Intelligence Council. 2016. Global Trends 2035.**
   https://www.dni.gov/files/documents/nic/GT_TumblrPosts_rev2a.pdf
   Excerpt includes a condensed version of global trends and critical uncertainties

3. **UK Ministry of Defence. 2014. "Strategic Trends Programme: Global Strategic Trends – Out to 2045."**
   https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348164/20140821_DCDC_GST_5_Web_Secured.pdf
   Excerpt includes a condensed version of the defense and security implications of regional trends

4. **Additional Resources**
   Short list of additional global futures and nuclear futures resources that may be of interest

1. Joint Operating Environment (JOE) 2035: The Joint Force in a Contested and Disordered World

Executive Summary

The future security environment will be defined by twin overarching challenges. A range of competitors will confront the United States and its global partners and interests. *Contested norms* will feature adversaries that credibly challenge the rules and agreements that define the international order. *Persistent disorder* will involve certain adversaries exploiting the inability of societies to provide functioning, stable, and legitimate governance. Confrontations involving contested norms and persistent disorder are likely to be violent, but also include a degree of competition with a military dimension short of traditional armed conflict.

These connected challenges are shaped by a wide range of trends and conditions. The future *World Order* will see a number of states with the political will, economic capacity, and military capabilities to compel change at the expense of others. In *Human Geography*, a range of social, economic, environmental, and political pressures will push states past the breaking point, spilling over borders, and creating wide-ranging international problems. The future of *Science, Technology, and Engineering* will see others reaching for technological parity, as well as designing innovative mixes of high and low technology that may allow adversaries to more effectively challenge US interests.

The intersection of trends and conditions reveals the changing character of war. The future of conflict cannot be understood in terms of individual trends. Issues and problems intersect, reinforce, and compound across many diverse areas. Sometimes relationships are clear, but more often they interact in unanticipated and surprising ways. Thinking through combinations of trends and conditions over many disciplines allows us to better anticipate changes in the character of conflict and illuminate why the Joint Force may be called upon to address threats to US national interests.

Warfare in 2035 will be defined by six contexts of future conflict. In 2035, the Joint Force will confront *Violent Ideological Competition* focused on the subversion or overthrow of established governments. *Threatened US Territory and Sovereignty* will become increasingly prevalent as enemies attempt to coerce the United States and its citizens. *Antagonistic Geopolitical Balancing* by capable adversaries will challenge the United States over the long term and place difficult demands on the Joint Force over wide areas of the globe. Intimidation, destabilization, and the use of force by state and non-state actors alike will result in *Disrupted Global Commons* and *A Contest for Cyberspace*. Internal political fractures, environmental stressors, or deliberate external interference will lead to *Shattered and Reordered Regions*. Each Context of Future Conflict poses a troubling problem space for the Joint Force.

JOE 2035: The Joint Force in a Contested and Disordered World (cont.)

World Order
Shifting Strategic Relationships A combination of more capable competitors, more dangerous threats, and greater fiscal uncertainty is likely to make unilateral action by the United States more difficult and potentially less effective in 2035. Therefore, the United States will continue to pursue collective security arrangements with a large set of capable and often ideologically or culturally compatible actors. While the strategic importance of these relationships is likely to grow, diverse changes will make them more difficult to manage and operate. *Drivers: New poles of economic power, Rebalanced energy security, Weakening of traditional US Alliances, Emergence of new partnerships*
Powers Pursuing Regional Primacy In the future, some states will increasingly use coercion and force to change regional arrangements in their favor. Potential adversaries able to avoid or protect themselves from US power projection will gain the freedom of action to shape the behavior of their regional neighbors, sometimes through violence and coercion. This pressure is likely to take place through large scale conventional overmatch against local rivals combined with cost-imposing niche capabilities to deter US intervention. The ability to hold high-value assets or critical infrastructure at risk may constrain US involvement and improve the prospects for successful coercive strategies at local or regional levels. *Drivers: Refinement of state hybrid stratagems, Intensification of warfare by proxy, Establishment of regional nuclear deterrents*
Regional Powers Attain Global Reach Should competitors consolidate a measure of regional primacy, the next logical step will be to invest in the capabilities necessary to assert themselves even farther from their borders both globally and across regions. The leading edge of this new global reach will be investments in more advanced cyber capabilities. Strategic attacks will likely focus on disrupting elements of the US financial infrastructure, where trust and data integrity are paramount. Furthermore, US energy infrastructure, dependent on industrial control computers, might also be a focus for adversary cyber activities. Additionally, a wider and more capable array of missiles, aircraft, surface vessels, and subsurface platforms will extend the physical reach of some powers. *Drivers: Increased competition across the air and maritime domains, Emergence of new spacefaring nations and military competition in space, Growth of state-sponsored cyber forces and capabilities*
Evolving Roles of International Institutions A number of states around the world are investing in new political, economic, and security arrangements to reflect their growing power and confidence. Fundamental differences with regard to natural resource issues, human rights, and responsibilities in the maritime, air, space, and cyber domains will prevent existing global governance frameworks from adequately managing some emerging security challenges. While most rising powers are likely to focus on gaining greater access and influence within the current international system, some states will be willing to use violence or coercion to revise certain aspects of the international order. *Drivers: Contested international rules, Erosion of standing institutions of international order, Emergence of alternative institutions of international order*
Connected Consequences of Fragile and Failing States There will be additional instances of weak states becoming failed states in the future. While the specific circumstances behind each failure will differ and include a mix of real or perceived corruption, economic inequality, and ethnic/religious discrimination, the root cause of these conflicts will often be traced to the inability or unwillingness of central governments to provide effective and legitimate governance. Consequently, as internal authority is challenged and begins to collapse, violence is likely to occur in the form of sectarian strife, insurgency, or civil war. *Drivers: Continuing internal collapse of weak states, Fracturing of weak states by external powers, Uncontrolled spread of weapons of mass destruction, Inability to contain infectious disease*

JOE 2035: The Joint Force in a Contested and Disordered World (cont.)

Human Geography

Population Growth & Migration

By 2035, the global population is expected to increase by another 1.8 billion people to a total of nearly 9 billion people, with almost all of this growth occurring in the developing world and largely centered in urban areas. When properly harnessed, population increases and urbanization can translate into stronger economic development and expansion. However, massive population growth and migration might stress governments to the breaking point where they are unable to effectively manage resources and meet their citizens' basic needs. Unequal rates of economic growth and the lack of opportunity are already inducing unexpected migrant flows, stressing recipient states and limiting the prospects for growth and development in places they leave behind.

Drivers: Asymmetric population growth patterns, Mass migration and irreconcilable immigrants, Mass migration and rejected immigrants or minorities

Urban Security

Humanity is now a predominantly urban species. Urbanization will likely continue to increase into the foreseeable future, with some 60% of the global population living in cities, usually near oceans, by 2035. The pace of urbanization is expected to be the fastest in lower-middle income countries. Many cities are likely to see significant and consequential economic, political and social advances. However, some cities will struggle to cope with the challenges posed by poverty and inadequate or aging infrastructure. Paradoxically, the adoption of information technologies will outpace the provision of adequate transportation, sanitation, and other necessities, leaving poor urban areas as heavily instrumented and connected to the global information environment as today's most developed cities.

Drivers: Demand for food or water exceeding local capacity to affordably deliver, Expansion of under-governed urban spaces, Emergence of global cities as international actors

Evolving Ideological Conflict

Identity is defined as the set of characteristics by which a person is recognizable or known. Humans define their identity in many ways, including religion, ethnicity, race, language, gender, tribe, class, occupation, geography, and nationality. Increasingly permeable national borders mean that human society will discover many more ways for ideas, images, narratives, and messages to propagate in the future. However, more contact between cultures is just as likely to result in negative consequences as positive. People of all cultural and ideological persuasions are frequently repelled or even disgusted by new ideas, cultures, or customs.

Drivers: Declining legitimacy of state authority, Rapidly shifting group identities, Increasing ideological polarization

Alternative Hubs of Authority

Over the next two decades, the distribution of power will continue to transition away from a state-centric world towards a multi-level, multi-nodal model, characterized by competition for control and influence between different institutions, groups, and individuals. By 2035, varying kinds and degrees of economic, informational, and ideological power will be exercised by non-state actors such as non-governmental organizations (NGOs), private corporations, extremist groups, or empowered individuals that may include celebrity figures and the wealthy. As a result, formal governing organizations and mechanisms within states will become increasingly less effective, while informal networks will increase their capacity to control or drive international and domestic outcomes.

Drivers: An accelerating diffusion of power, Cooperation/convergence among terrorist and criminal organizations, Globalized criminal and terrorist networks

The Rise of Privatized Violence

States will find it increasingly difficult to maintain a monopoly on the use of force. Private and non-state groups, in the absence of strong or legitimate states, will increasingly turn to violence to advance their political, social, ideological, or economic goals. Sub-state and transnational actors will be enabled by the ability to rapidly share information through mobile devices and associated social media platforms. Collective action and popular movements, which once took months or years to build, will be catalyzed in hours. Small determined groups or even lone radicalized individuals will wield enormous influence using "off grid" mesh networks to disrupt the political/ social order of a nation.

Drivers: Adaptive irregular/sub-state adversaries, Disruptive manufacturing technologies and the urban arsenal, Weaponization of commercial technologies

JOE 2035: The Joint Force in a Contested and Disordered World (cont.)

Science Technology and Engineering

Multidisciplinary Research

By 2035, many important scientific advances will result from an emphasis on how differing phenomena interact and how seemingly diverse technological domains relate to one another. They will frequently take place where two or more disciplines converge, particularly in the rapidly evolving areas of biology, robotics and autonomy, information technology, nanotechnology, and energy. Many consequential technological changes are less likely to emerge from a DoD lab or single research institution, but from ongoing work across clusters of collaborative research and development efforts – typically geographically dispersed and sometimes international in nature.
Drivers: Applied metamaterials, Exploitation of unique material properties at the nanoscale, Fuels and batteries with increased energy density, Biochemistry and biological engineering

Systems Integration

The corollary to change in multidisciplinary basic research at the engineering level is the importance of systems integration to make emerging technologies economically or militarily useful. Effective technology integration into military operations requires the capacity to bring together many different capabilities into a coherent, purposeful whole. Even today, the largest, most capable states struggle to match their ability to develop individual technologies with the ability to integrate these technologies into a single system. By 2035, improvements to individual devices, tools, or platforms will likely become less important than the system architectures which allow dissimilar capabilities to work together coherently.
Drivers: Additive manufacturing goes global, Evolution of autonomous robotic systems, Open source design, Emergence of micro/nano-satellites and near-space capabilities

Emerging Measure/ Countermeasure Competitive Spaces

Technological change will result in new types of competitive interactions among military forces. The most pressing of these will be the contest of “hiders” vs. “finders” on the battlefield. Adversaries will continue to offset US airpower and other long-range strike advantages by developing well-protected underground facilities, hardened fiber optic networks, and numerous high quality decoys, both virtual and physical. They will also focus on developing long-range strike capabilities and an evolving array of sensor and missile technologies to limit US power projection capabilities. Regional reconnaissance-strike complexes will target the expensive, few, and/or easily locatable bases and platforms upon which current US forward presence relies.
Drivers: Proliferation of advanced radio-frequency weapons, Availability of non-nuclear EMP, Robotics as a force multiplier

Proliferated Information Technologies

Very powerful information technologies will be widely available around the world by 2035, including wireless handheld or even brain-interfaced devices with advanced levels of connectivity. More modern developing states will continue to construct comprehensive national information technology infrastructures consisting of fiber-optic and cellular networks that far exceed the current state of the art. Potential competitors will have access to huge volumes of commercially-available geospatial and other geophysical data that once cost billions and was available to only to the richest and most technically-competent countries.
Drivers: Regional Command, Control, Communication/Intelligence, Surveillance, Reconnaissance parity, Exploitation of C3/ISR vulnerabilities, Advanced information analysis and exploitation, Quantum information science

Emergence of New High-End, Capital Intensive Capabilities

Although cheap, pervasive, and proliferated capabilities such as personal information technologies or small autonomous aerial vehicles attract a great deal of attention, a number of expensive, investment-heavy technologies will emerge by 2035 that may provide significant military advantages. Many of these advanced and highly capable technologies will only be accessible to states with significant financial and scientific resources as well as extensive industrial and manufacturing infrastructure. Thus, the fascination with small and cheap must be balanced against an appreciation for capital-intensive weapons and industrial technologies with the potential to dramatically alter the strategic landscape.
Drivers: Deployment of >100 KW electrical lasers, Breakthrough energy, Hypersonics

2. National Intelligence Council – Global Trends 2035

Global Trends & Uncertainties
How People Prosper During the next 20 years, global economic growth, trade expansion, and convergence of advanced and emerging market countries will continue, but at a much slower pace than in recent decades. Inequality within countries will become far more consequential than inequality between countries. • To what extent will societies and governments adjust to technology's transformation of the nature of work and its impact on inequality patterns? • Will global patterns of interdependence and connectedness persist, especially with respect to rules governing finance, trade, and information?
How People Live The decades to come will bring increasingly palpable changes to Earth systems—arising from both natural and man-made causes, including urbanization—that will make the planet less resilient and will expose humans to new health, food, water, energy, and infrastructure vulnerabilities. • Will individuals, governments, and private, civil, and international organizations partner in new ways to build critical human support systems? • As some parts of the world become accessible, like the Arctic, or unlivable—in the Arabian Peninsula—how will political leaders and populations respond, will new territorial claims and conflicts emerge, where will climate refugees go, how will they be received, and will international and national laws be adjusted?
How People Think Values confrontations and ideological differences between and within societies, cultures, polities, and regions will continue to be politically salient during the next two decades. • Will leaders and movements embrace inclusive, big-tent ideologies—whether religious, liberal, populist, or nationalist—displaying and delivering security in the face of uncertainty? If not, who will be left out and why? • Will emerging and future ideas about the social contract—what governments and citizens owe one another—address privacy and inequality dynamics, which will be made more prominent by advances in technology? • To what extent will individuals, corporations, and governments use technology's disruptions to renew and strengthen societies and address its insecurities, or allow technological disruption to destroy social and political order without creating alternative paths to inclusive peace and prosperity?
How People Govern Governments and international institutions will face daunting challenges during the next 20 years, with cities often faring better than national governments and international responses becoming more dependent on the strength of broad, multi-stakeholder partnerships. The growing stock of internal and external challenges before political authorities will far exceed the capacity of most governments and international institutions to address alone, while the changing nature of power will force adjustments in how political authorities secure sustainable outcomes. • To what extent will the roles of government adjust vis-à-vis other actors to reflect the changing nature of power and poplar demands for new social contracts? • Will governments in the developing worldwide facilitate investment in human capital and improve capacity of state or other institutions to deliver security, welfare, or other services? • To what degree will international institutions formally evolve to allow for the changing nature of power and enable cooperation in a period of heightened geopolitical tension and insecurity?
How People Fight Diverging interests among major powers, ongoing terrorist threats, continued instability in weak states, and the spread of lethal and disruptive technologies suggest heightened opportunities for conflict during the next two decades. The character of conflict, however, is changing because of technology advances, new strategies, and the evolving global geopolitical context. • Will major powers invest in confidence-building measures to manage the risks of increasing geopolitical competition and miscalculation owing to the changes in the character of conflict? • How will state and non-state actors adjust to long-range strike systems, cyber attack capabilities and more sophisticated terrorist/insurgent operations that may result in costly, but less decisive conflicts? • To what extent will states and non-state actors abide by or alter the laws of warfare?

3. UK Strategic Trends Programme: Global Strategic Trends – Out to 2045

Defense and Security Implications of Regional Trends
North America • Although China is likely to surpass the US in GDP, the US is likely to remain, militarily, the most powerful country in the world. • A reduced need for Middle Eastern oil is unlikely to significantly alter the US commitment to the region, which will almost certainly continue to have a significant bearing on global stability and security. • NATO is likely to remain the key security alliance for Northern American countries, although US (and possibly Canadian) commitments elsewhere in the world may mean that European countries will have to take on more of the burden of maintaining security in their region.
Latin America and the Caribbean • While a Latin American arms race is unlikely, some countries are likely to have much more capable armed forces by 2045 than at present, with world-class capabilities in some areas. • The emergence of a nuclear-armed country in Latin America by 2045 cannot be ruled out, despite existing treaties to the contrary. The resources and knowledge to create nuclear weapons will be present in a number of countries in the region. • It is not likely that a narcostate will emerge in Latin America or the Caribbean by 2045, but drug cartels are likely to continue to have significant influence in a number of countries for the foreseeable future.
Europe • European countries' defense spending is unlikely to increase significantly without a major threat. • NATO is likely to remain the key organization for military crisis management, although its cohesion may be challenged by diverse threat perceptions, a US focus on Asia and internal disagreement on its global role. • Russia is likely to remain an influential regional power. Its assertiveness and power politics may cause future European security challenges.
Middle East and North Africa (MENA) • MENA is highly likely to remain a volatile region over the next 30 years and the possibility of major regional conflict cannot be ruled out. The possible thawing of relations between Iran and the US could have significant implications for regional security. • Socio-economic factors, including disparity in wealth, gender inequality and poor education, are likely to be the underlying causes of much of the unrest and sometimes violent conflict within MENA. • Internal terrorist threats are likely to continue, as are attacks on other nations from groups based in the region.
Sub-Saharan Africa • The risk of state-on-state conflict is likely to reduce overall, although instability and violence will almost certainly continue out to 2045, possibly increasing in some areas. • Terrorist organizations are likely to continue to pose a threat to peace and security, driven by youth unemployment, dissatisfaction with governing regimes and the mismanagement of natural resources. • The combined challenge of an increased population, demands on resources and the effects of climate change (particularly drought) on food and water supplies are likely to lead to tension, which could result in conflict.
Central Asia • Although all the major regional actors have an interest in Central Asia, none appear to have a strategy of territorial expansion into the region or of becoming directly involved in security issues. • The primary triggers of instability in Central Asia remain rooted in the internal politics of each country. Countries in the region are likely to remain vulnerable to significant political and social threats that, in turn, pose risks to the region's security.
South & East Asia and Oceania • In large part because of its economy (likely to be the largest in the world by 2045), South & East Asia will probably be of increasing strategic significance. • A growing population, increasing demand and the effects of climate change are likely to lead to food and water shortages. Rising sea levels are likely to lead to humanitarian disasters which may require international

Defense and Security Implications of Regional Trends

assistance.

- By 2045, China's military capability may be close to matching that of the US, perhaps exceeding it in some areas. India's military capability is also likely to increase – but probably not to the point where it rivals China or the US by 2045.
- The East and South China Seas may be flashpoints for confrontation between China and the US and allied countries. Similarly, Kashmir, the Korean Peninsula and the border between China and India are likely to be areas of tension. The risk of a major state-on-state conflict in the region cannot be ruled out.
- Terrorism will almost certainly continue to pose a threat in South & East Asia, less so in Oceania. High levels of inequality based upon class, ethnicity and religion are likely to endure as sources of tension across the region and may impact on the overall governance and stability of some countries.

4. Additional Futures Resources

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