SMA USCENTCOM Panel Discussion

Black Swans and Gray Rhinos in the USCENTCOM AOR: Vigilance Against the Unsuspected and Keeping Our Eyes on the Prize

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Executive Summary

Four panelists with deep knowledge and experience in the USCENTCOM AOR and with complex systems modeling were asked to reflect on how to think about and anticipate surprises in the USCENTCOM area of responsibility (AOR), especially Black Swan surprises that are the product of non-linear relationships between interacting variables. The panelists shared a wealth of knowledge on the region and complexity. Key takeaways included:

- The aim of complex modeling is to provide strategic success—the US needs to be able to anticipate surprises and their likelihoods to plan against them instead of reacting to events as they unfold.
- Black Swan surprises emerge as a result of non-linear relationships between system variables, but also high dimensionality and the interdependence of key variables.
- Examples of the variables that interact in complex ways in the USCENTCOM AOR include unstable governments and economies, ineffective conflict management, uncoordinated development, ethnic and religious diversity, and climate change.
- Actual modeling must be done, and not simply using metaphors of complexity. The warfighter users of complex modeling need the skills to build models and understand them and, at a minimum, they must understand assumptions and actionable results.
- Data are a problem. Data exist at the country level, but the complex dynamics that really need to be understood operationally are sub-national if not local. Efforts must be undertaken to fill this gap, which also includes data on past known Black Swans in the AOR.

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Background

On 4 March 2020, the Strategic Multilayer Assessment (SMA) office held a panel, entitled *Black Swans and Gray Rhinos in the USCENTCOM AOR: Vigilance Against the Unsuspected and Keeping Our Eyes on the Prize*. The purpose of the panel was to explore how to think about potential surprises in the USCENTCOM AOR that could impact US national security interests. Of particular interest were the kinds of surprises that have become known as Gray Rhinos and Black Swans. Gray Rhinos are trends for which there are data that can be monitored; they surprise us simply because we are not looking (Wucker, 2016). In contrast, Black Swans are sudden, unexpected surprises that are the result of non-linear interactions and rare events that, by definition, cannot be predicted (Bellomo, Herrero, & Tosin, 2013; Taleb, 2007).

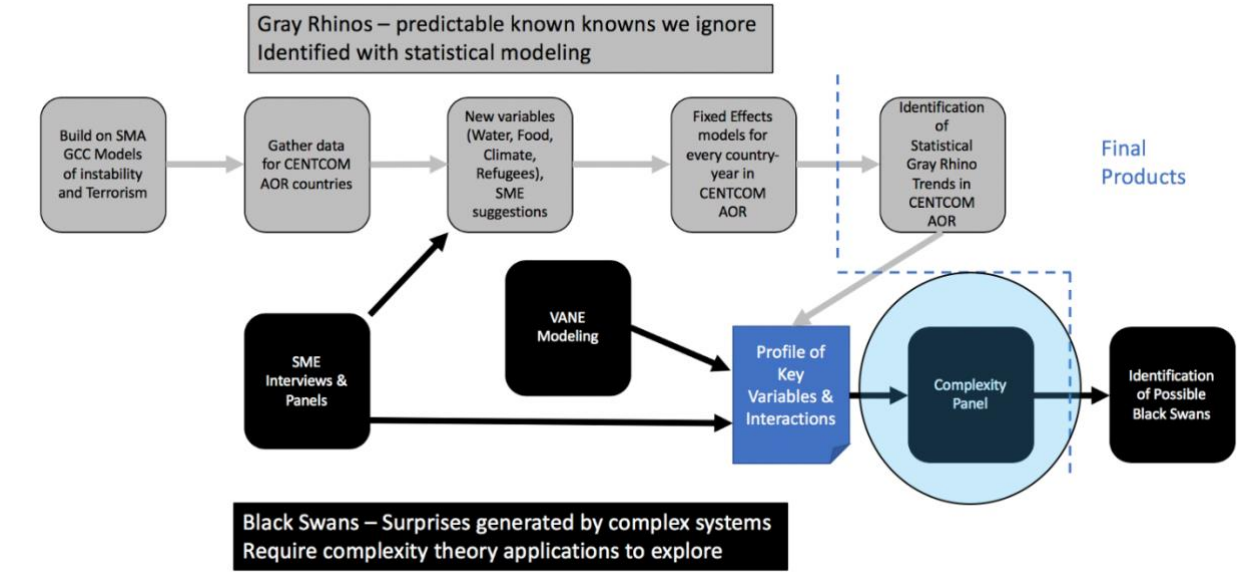

Figure 1. NSI Black Swan/Gray Rhino Project—Place of Panel

The panel was the culmination of a six-month effort involving statistical research, subject matter experts (SME) interviews, literature reviews, and machine learning capabilities to address these kinds of surprises in the USCENTCOM AOR (Figure 1). In order to identify Gray Rhinos that can be feasibly monitored and anticipated in the USCENTCOM AOR, NSI, Inc. developed statistical models based on regional data (Kuznar & Day, 2020). A parallel effort to explore potential Black Swans involved interviews with subject matter experts on climate change and water issues in the Middle East, ethnic and sectarian issues in the Middle East and Central Asia, and Middle Eastern refugee flows (L. Kuznar & E. Kuznar, 2020), the application of a machine learning capability to data streams from the region (Jafri, Kuznar, & Day, 2020),[1] and insights gleaned from the statistical modeling (Kuznar & Day, 2020). Finally, NSI, Inc. developed statistical models and applied machine learning methods to their data on the USCENTCOM AOR in order to discover Gray Rhinos and potential tipping points and key thresholds that could lead to instability and terrorism in the USCENTCOM AOR (Kuznar & Day, 2020).

This panel was set-up as a quasi-experiment to apply rigorous systems and complexity thinking to these research efforts. Key insights from these bodies of research were presented to the panelists in advance of the panel in order to provide them with a common knowledge base. However, the panelists were chosen based on their own extensive background knowledge of the region and their experience with complexity theory, and they were free to use that information at their discretion.

First, a synopsis of the panel implications is presented, followed a detailed point-by-point account of the proceedings.

Synopsis of Implications

There were several themes that converged in most of the panelists remarks, including the purpose of modeling complex systems, general comments on complexity, dimensionality and interactions, the need for sub-state data, and operational requirements.

Dr. Cioffi-Revilla began the panel by stressing that the aim of complex modeling for national security should be strategic excellence with lasting success, rather than simply reacting or muddling through crises. His point is well-taken, and echoes the calls for advanced modeling articulated by scientists and government officials for nearly two decades (Bhattacharjee, 2007; Popp, Allen, & Cioffi-Revilla, 2006; SImons, 2014; Zacharias, MacMillan, & Hemel, 2008).

All of the panelists made comments on the general need for modeling complex systems. Dr. Cioffi-Revilla stressed that complexity emerges out of more than just non-linear interactions, to include high dimensionality (numbers of variables and factors), large cardinality (number of actors, number of contingencies, other significant numbers), and interdependence between variables. Dr. Lawson stressed that many Black Swan events are actually the symptoms of mundane butterfly effects, and that we should be looking for those mundane butterflies and the conditions that lead to their occurrence. In addition to noting the need for complex thinking, Dr. Cioffi-Revilla and LTC Pike noted that analysts must get past metaphors and simple data analysis and employ actual modeling.

Dr. Cioffi-Revilla suggested an approach for developing models of rare, Black Swan events. He suggested that one can develop models that reproduce these events. Some Black Swan events have known power-law distributions, such as warfare fatalities, terrorism, and population concentrations (Cederman, 2003; Cioffi-Revilla, 1998; Cioffi-Revilla & Romero, 2009). These probability distributions already can be used to

[1] VANE (Virtual Anticipatory Network) is a machine learning capability under development by the Combatting Terrorism Threat Support Office (CTTSO), and NSI, Inc. used it to explore how thresholds in some variables (e.g. unemployment, precipitation levels, GDP) impact other variables on the country-level.

model their occurrence and risks. The issue of what prediction means came up in the audience Q&A, and Dr. Cioffi-Revilla noted that seismologists cannot predict the exact *timing* of "the big one," but the data from their instruments can indicate where *and exactly of what magnitude* such events are more likely (e.g., a Richter-mag 9 in San Francisco), and that modeling social Black Swans has the same potential.

Related to the panelists' call for complexity modeling and thinking, they commented on the importance of dimensionality and interactions. Dr. Cioffi-Revilla noted that before the modern era, strategists only had to consider the interaction between the dimensions of land and sea, but today the operational environment is characterized by at least five domains (land, sea, air, space, and cyber), which is super-exponentially more complex. To illustrate his point very simply, if Alexander the Great had two land elements and a naval element and wanted to coordinate these two kinds of elements, he would have to consider a permutation of three elements taken two ways, which equals six combinations, which is within the well-established 7 ± 2 rule for human short-term memory and cognition in general (Miller, 1953). In today's warfare, the permutation of five elements each taken two ways is 20, well beyond the number of elements a person can expect to juggle in his or her head simultaneously. The reality, of course, is far more complex and exponential.

Drs. Wilkenfeld and Lawson noted that interactions between known variables can lead to complexity. Dr. Wilkenfeld noted five challenging issues in the USCENTCOM AOR—1) Unstable governments, economic underperformance, and the spread of instability to others, 2) Ineffective conflict management, 3) Uncoordinated global development, 4) Ethnic and religious diversity that fuels conflict, and 5) Human induced climate change. Complex interactions between these issues are where unexpected and dramatic events are likely to emerge. An example of complexity at this level emerged from a panelist interaction regarding the dynamics of state stability and the transition from autocracy to democracy. LTC Pike noted that democracy "lives on the edge of chaos," and Drs. Wilkenfeld and Lawson cited the well-established dynamic that as states move from autocracy to democracy, they become more unstable (Bates, 2008; De Soysa & Neumayer, 2013; Elbawadi & Sambanis, 2002; Fearon & Laitin, 2003; Iqbal & Starr, 2007). This specific example was reproduced in the Gray Rhino research conducted for this study and previous SMA research (Kuznar & Day, 2020; L. Kuznar, E. Kuznar, & Aviles, 2019).

All panelists commented that while data aggregated at the country-level was useful, there is a need for sub-state data. Dr. Cioffi-Revilla made the point that a map without provincial and local data is largely useless. Dr. Wilkenfeld pointed out that we are concerned with human security, and that this operates at a dimension different from the nation-state, undefined by borders, and concerned with rights and the environment. Dr. Lawson's point about the impact of mundane butterflies seems to echo this point that the relevant data for modeling Black Swan events occur at an intimate, local level.

LTC Pike stressed the need for operationalizing complex modeling and placing it in the hands of the uniformed users. The practical purpose of doing so is to influence the adaptive pathways local populations take in order to increase the likelihood of outcomes favorable to US interests. He maintained that, as essential as reading was for the operational effectiveness of the WWII soldier, the modern warfighter needs to have at least a rudimentary knowledge and understanding of computer coding. Dr. Lawson wondered how we can ensure that operators do not misconstrue or misuse complex models once they are put into their hands. LTC Pike noted that this reemphasizes why warfighters need to be trained in modeling techniques; if they build the models, they will understand their uses and limitations. The military trained its servicemembers to use M4s, tanks, and planes because they are essential for warfare in the 20th century. Computational tools from machine learning to agent-based models are essential tools for waging war in the 21st century so likewise our servicemembers must be proficient at them.

Panel Proceedings

The panelists included (full panelist biographies are presented in the Appendix):

- Moderator, **Lawrence A. Kuznar**, PhD, NSI, Inc. and professor of anthropology, Purdue University, Fort Wayne.
- **Claudio Cioffi-Revilla**, PhD, professor emeritus, political science, George Mason University.
- **Sean Lawson**, PhD, associate professor, communication, University of Utah.
- **Lieutenant Colonel Tom Pike**, Joint qualified, Strategic Intelligence officer, United States Army; faculty, National Intelligence University, and Co-Director, Anticipatory Intelligence and Adaptive Influence (AI2) Center.
- **Jonathan Wilkenfeld**, PhD, professor of government and Politics at the University of Maryland.

The panel began with opening remarks from the moderator, then each panelist spoke for 10 minutes about Gray Rhinos and Black Swans in the region. This was followed by 20 minutes of discussion between panelists, and the remaining 25 minutes was devoted to audience questions and answers. What follows is a synopsis of the panelists' paraphrased remarks, the panelists' point-by-point comments, and the panelists' discussion.

Paraphrased Remarks

Moderator Dr. Kuznar began by defining Black Swans as "high-impact, unpredictable surprises induced by complex interactions," and Gray Rhinos as "high-impact, probable events that individuals should not have neglected but did."

Next, Dr. Cioffi-Revilla stated that strategic excellence aimed at lasting success should be the goal that USCENTCOM strategists and planners are trying to achieve, rather than coping or muddling along. He reflected on Gray Rhinos, highlighting that more effort needs to be taken to observe Gray Rhinos at the provincial, local, international, and global levels, as opposed to just the country level. Accordingly, he encouraged the combatant commands (COCOMs) to consider whether the current AOR distinctions need to be adjusted. Dr. Cioffi spoke about Black Swans as well. He emphasized the importance of understanding features of complexity and the high dimensionality of situations. He also stated that understanding the relevant distribution of Black Swan events of interest is essential and that data analysis itself is insufficient; one must add mathematical modeling to the mix. To conclude, Dr. Cioffi suggested that by collecting a small dataset of past, known Black Swans in the AOR, one could compare their characteristics and potentially model the onset of future events. The knowledge gleaned from such models could then be integrated into COCOM strategies.

Dr. Lawson based his portion of the discussion on two of his research projects, which examine the way in which the United States defense community applies theories of nonlinear science and complexity. He began with a reminder that butterflies are "the other winged creatures of chaos." Much of human history is shaped by such events, and some may be passing without our immediate recognition of them. He stated that what we perceive as large, visible Black Swans may actually be ripple effects of other events caused by more mundane, less noticeable butterflies. Consequently, Dr. Lawson advised that US decision makers look for the butterflies in order to spot (and ideally prevent) Black Swans. He further suggested that rather than predicting Black Swans, the COCOMs could monitor the emergence of certain conditions that make it more likely for a Black Swan event to occur. He also cautioned that US decision makers be particularly wary of the effects of feedback and the possibility of self-fulfilling prophesies. To conclude, Dr. Lawson stated that the region's ability to respond to some Gray Rhino events, such as climate change, is linked to good governance—something that USCENTCOM should promote.

LTC Pike then suggested that USCENTCOM direct its focus to the local groups that are competing for resources and the dynamics of their competition in order to influence them. This is where USCENTCOM will find the Gray Rhinos and Black Swans emerging, rather than at the aggregate nation state level. LTC Pike also stated that US decision makers could influence the adaptive path of populations in order to (ideally) produce their own Gray Rhinos. To do this, decision makers should monitor these groups and identify ways in which they (the decision makers) can avoid being predictable. Simulations can also help identify high-level points of leverage and keep costs low. LTC Pike noted, however, that the success of these efforts is unpredictable, and simulations will never produce results that are exactly right. LTC Pike concluded by stating that 1) to gain a deeper understanding about how populations in its AOR are interacting and behaving, USCENTCOM must leverage computational tools to simulate their behavior and 2) as these simulations will always be flawed, USCENTCOM and the USG at large need to catalyze the growth of the simulation infrastructure so analysts, strategist, policy makers, etc. can build their own custom models.

Lastly, Dr. Wilkenfeld stated that the United States is facing Gray Rhino situations that could eventually turn into Black Swan situations. He proposed that human security is at the core of Black Swans' potential to occur and can help explain how they can affect international patterns moving forward. He presented five threats that the international system faces today: 1) unstable governance and underperforming economies, 2) ineffective conflict management (both at the local and international level), 3) uncoordinated global development strategy due to widespread corruption, 4) insufficient focus on how diversity can lead to tensions and conflict, and 5) inability to deal with the impact of human activity on climate in a timely manner. These threats oftentimes converge in a way that we may not anticipate over the long-term. Dr. Wilkenfeld then stated that one can minimize the impact of Black Swans in the future by collecting and analyzing data and metrics on these events. He also stressed the need for collective action in order to address critical global crises impacting human security—a concept of security that is people centric and without borders. "We all live downstream," according to Dr. Wilkenfeld; global norms and institutions develop when nations and their leaders recognize that collective action is beneficial not only for the global system, but also to their own individual nations.

Panelist Remarks Point-by-Point

Claudio Cioffi-Revilla, PhD, University Professor Emeritus Political Science, George Mason University, Fellow AAAS

1. **Introduction**
   - 1.1. Two premises are necessary for **contextualizing** Gray Rhinos and Black Swans *anywhere.*
     - 1.1.1. **Strategy**: Strategic excellence with lasting success must be the goal or standard, not just coping or muddling through. Understand the requirements of strategic excellence and lasting success in the USCENTCOM AOR.
     - 1.1.2. **Domains**: There are five operational domains of current strategy (land, sea, air, space, and cyber), which is three more than the last time Afghanistan was conquered by Alexander the Great. Understand that a 5-domain strategic environment is super-exponentially more complex than a 2-domain space of just land and sea.
   - 1.2. **Both premises**, on strategic excellence and 5-D operational domain, require careful and systematic consideration (i.e., scientific application to the next two points on Grey Rhinos and Black Swans) **in order to derive actionable inferences and insights.**
2. **Gray Rhinos hiding in plain sight**
   - 2.1. **Levels of analysis.** While the **country** level of analysis is preferred (a cognitive and institutional attractor of sorts), **provincial and local** data and analysis, as well as **international and global** data

and analysis, are essential for assessing issues, capacities, policies, prospects in the USCENTCOM AOR of 550 million people, 20 countries, 22 ethnic groups, 4 million square miles, 18 languages, etc.

2.1.1. Look at what is happening **below** and **above** the prevalent national level of analysis favored by most analyses. Maps without provincial, local data are mostly useless for many analyses.

2.1.2. Use maps provided by human geography to inform COCOM and leadership staff, as well as stakeholders.

2.2. When was the **map** of the USCENTCOM AOR drawn? Every neighbor of Israel is in the AOR; while Israel is not. Nor is the main adversary of Pakistan, India. Is the current AOR a **meaningful strategic entity** for planning and operational purposes? Which changes would warrant redrawing the composition and borders of the USCENTCOM AOR? (When is the global AOR map of all regional COCOMs due for review?)

2.3. What does the **dashboard** of the USCENTCOM AOR look like? Is there a dashboard? How was it designed? How is it maintained? How does it compare with the dashboards of neighboring AORs (i.e., INDOPACOM, AFRICOM, EUCOM)?

2.4. Beyond the statics, which are the **critical time-series** that we monitor (e.g., in terms of WMD horizontal and vertical proliferation)? How is the **time-series analysis** (TSA) performed? Does it include **time-varying hazard functions** for monitoring proliferation risks? How much TSA is performed at the local provincial levels?

2.5. How is the **standard polity model** being applied to each country, region, and province? What is the ranking of contentious polities (i.e., governance ranked by difficulty due to factionalism, or polities ranked by contentiousness over competing authorities)?

3. Black Swans generated by complexity

3.1. Understand other features of complexity and Black Swans, **besides nonlinearities**: high dimensionality, large cardinality (number of actors, number of contingencies, other significant numbers), interdependence, and others, including the mathematical underpinnings, not just the metaphors (e.g., how the current WMD proliferation landscape in the AOR can generate Black Swans via strategic interdependence with India and Israel, both "outside the AOR").

3.2. Understand the **relevant distributions of extreme events** of interest.

3.2.1. Exploit data to infer actionable information. What does the START Global Terrorism Database (GTD) distributions show for the USCENTCOM AOR?

3.2.2. Data analysis is insufficient—we must add formal mathematical analysis to deepen theoretical and actionable understanding.

3.3. Understand the theory and practice of **modeling one-of-a-kind events**, especially extreme "Black Swan" events.

3.3.1. Select past Black Swans of interest: Which are they? How many? (e.g., the Pakistan nuclear proliferation? Iranian Black Swans? Was the Iraq invasion of Kuwait a black swan?).

3.3.2. Model their onset, using well-established statistical and mathematical methods.

3.3.3. Compare models across types of Black Swans, time periods, levels of analysis, etc.

3.3.4. Use the above to infer actionable information for Black Swans in this AOR.

3.4. What do results from one-of-a-kind modeling say about **estimating probabilities** and **risks** of Black Swans in the AOR?

3.4.1. What about objective vs. subjective probability estimates, based on behavioral cognitive science? Are analysts being trained on heuristics for estimating probabilities?

3.5. **Known vs. unknown** Black Swans.

3.5.1. Known: warfare fatalities, terrorism, population concentrations, and others have highly skewed, power-law distributions that are known to generate Black Swans. Understand these in all aspects.

3.5.2. Unknown: What are some distributions of concern that we have no data for? Understand how to use the theory and practice of generative processes to model such distributions using

statistics and math. Even without empirical support, some actionable insights might be gained through formal analyses.

3.6. Consider the **ordinal scale of calamity** used in emergency management and disaster science for understanding Black Swans in the AOR: local emergencies (are solvable), disasters (also solvable assuming some allied help), catastrophes (not solvable with any level of outside/allied help), extinction events (end of story scenarios)

3.6.1. What does the history (time-series) of Black Swans in this AOR look like?

3.6.2. What does the Markov chain look like? Properties? Actionable inferences?

4. Concluding Remarks

4.1. These observations are mostly about assessing the situation **today** in the USCENTCOM AOR.

4.2. A useful next step would be to estimate **future** situations, which will be somewhat different and more challenging, but necessary to improve policies.

4.3. These and other considerations should be included in the Command's strategy and plans, because Gray Rhinos and Black Swans are highly consequential and often responsible for existential risks and catastrophic failures.

Sean Lawson, PhD, Associate Professor Communication, University of Utah

Thank you for inviting me to be part of the panel today. My thinking about today's topic is shaped by two main research projects over the last decade or so. The first was an investigation of the ways in which the US defense community has engaged with and attempted to learn and apply lessons from nonlinear science, including chaos, complexity, and network theories. That first project resulted in a book, titled *Nonlinear Science and Warfare*, published in 2014. The second project relates to how we often talk about risk in the US cybersecurity debate. In particular, I investigated how and why we have a tendency to focus on improbable doomsday scenarios potentially at the expense addressing the more mundane but still damaging attacks we see on a daily basis. I just published a book on that subject in January 2020.
The main points I would like to share at the start are a series of caveats based in some of the flaws I have observed in our prior attempts to learn and apply lessons of complexity and to think about cybersecurity risks. The first is to remember that:

1 - Butterflies are the other winged creatures of chaos.

We tend to think of Black Swans as large, visible, and recognizable surprises or shocks to the system. When they happen, you can't miss them. The terrorist attacks of September 11, 2001 or the financial crash of 2008 are often used as examples. However, if Nassim Taleb is correct that much of history is shaped by such events, then it stands to reason that some, perhaps even many, of these events might pass without our immediate notice. As a result of the butterfly effect, it may be the case that what we perceive as a Black Swan event is merely a ripple effect of some smaller, unnoticed event or combination of events. The visible Black Swan may be just a symptom. In the classic example, the hurricane is the symptom of the butterfly flapping its wings, perhaps in some far-off location. Though the hurricane certainly changes things on the ground for those who experience it, it was the result of other, more mundane events. One implication of this is that:

2 - To find the Black Swans, look for the butterflies.

Taleb is clear that a true Black Swan is a surprise, that it is, by definition, unpredictable. But he is also clear that a Black Swan is in the eye of the beholder. That is, a large-scale shock might be a Black Swan to some but not to others. Preventing Black Swans, then, is not so much about preventing the occurrence of large-scale events that shock the system, but rather, reducing our own uncertainty and surprise about such events. To do that, I think we need to be vigilant in our hunt for the conditions of possibility for the emergence of Black Swans. We need to be on the lookout for the conditions that have the potential to

kick-off a nonlinear, butterfly-effect set of events resulting in the large-scale shock to the system. Doing so means we need to:

3 - Think less in terms of cause and effect, more in terms of conjunctures, configurations, or conditions of possibility.

Taleb is also critical of our tendency to think in simple narratives that offer linear, cause and effect relationships. This does not mean that we should not try to understand the world around us. It does mean that the way we approach the problem of knowledge in a complex system subject to nonlinearity and feedback may need to change. Instead of seeking to predict Black Swans definitively, we may instead need to focus on monitoring and detection of the emergence and coming together of certain events or conditions that, while they do not guarantee the advent of a Black Swan, provide the conditions that make it possible and potentially more likely. In turn, that means we:

4 - Should not focus on Black Swans at the expense of Gray Rhinos, especially when the two are integrated.

I have written about the tendency in the US cybersecurity debate to worry about potential cyber-doom scenarios. Those are the cyber Pearl Harbor-like catastrophic attacks that paralyze the entire country. At the same time, we can have a tendency to discount the more mundane, almost-daily occurrence of cyber crime, espionage, subversion, etc. We are indeed facing an evolving cybersecurity crisis, but not one that involves doomsday scenarios, at least not yet. In a situation where the risks of a Gray Rhino and Black Swan are essentially integrated, we need to:

5 – Beware of the effects of feedback and self-fulfilling prophecies.

In the case of cyber conflict, I worry that treating that crisis as a Gray Rhino, largely ignoring it while we in some cases worry instead about the more frightening Black Swan-style event, may turn out to be a self-fulfilling prophecy. This is because the two are not separate, but rather, integrated risks. They are within the same domain and the same conditions that contribute to the daily, mundane attacks, and if left unchecked, could ultimately increase the likelihood of the Black Swan-style event. In fact, some actions meant to address the possibility of the Black Swan, cyber-doom scenario may actually increase its likelihood in the long-term by undermining our ability to fight the lower-level threats that ultimately set the conditions of possibility for the Black Swan-style event.

So, what does all of this mean in terms of today's topic?

I am struck by the recurrence in the read-ahead materials of issues related to climate and good governance. Climate change is the most obvious Gray Rhino for the US government at the moment (and not just in the USCENTCOM AOR). What's more, the region's ability to respond to climate change is intimately linked to issues of good governance (e.g., corruption, repression, etc.) Good governance, likely because it is a less sexy topic, is also a Gray Rhino.

The read-ahead materials identify issues like water and food scarcity, heat, floods, and droughts as Gray Rhinos. But I would say that those are all subsumed under the larger issue of climate change. Indeed, even the problem of urbanization is intimately linked to climate through issues of food and water scarcity.

We also see evidence in the read-ahead materials of the potential for butterfly effects as climate and governance challenges combine. So, the materials note the impact of drought in Russia and China on the

Syrian civil war, as well as the follow-on flows of internally displaced people within Syria moving from rural to urban areas, further exacerbating the impacts of food shortages in urban areas already prone to such effects. In turn, we see the movement of refugees from the Middle East into Europe, which has contributed to the rise of right-wing political movements there and political instability.

Thus, the ever-impending effects of climate change, combined with the inability of local governments to respond effectively, together set the conditions for the kind of increased instability ripe for producing Black Swans that may, in reality, be the second, third, or fourth order effects of events that went barely noticed at the time (e.g., a drought in China leading to instability in Europe though the chain of events mentioned above. Thus, while it might be tempting to spend our time imagining frightening, Black Swan-style events, we should avoid doing so at the expense of addressing the Gray Rhinos, especially when the Gray Rhinos are likely a leading driver of whatever Black swans may ultimately emerge.

Lieutenant Colonel Tom Pike, National Intelligence University, and Co-Director of the Anticipatory Intelligence and Adaptive Influence (AI2) Center

An operational perspective.

1. Models based on country-level data are fine, and they exist because much of the data that interests us is aggregated at that level, but what is needed is data at the local level.
2. We need models at the local level in order to influence the adaptive path of local populations in the hopes of avoiding Black Swans and producing Gray Rhinos, or trends, that favor US national interests.
3. There is a need for genuinely complex models, in the sense of complexity theory.
4. However, how do we give these tools to the people who need to use them? What are the knowledge, skills, and abilities users need to have? How do we train them?

Jonathan Wilkenfeld, PhD, Professor of Government and Politics, University of Maryland

1. We should not forget the human dimension; human security is where Black Swans will occur, and where human lives will be impacted.
2. There is a need for better data and analysis at this human level.
3. Analyses should be centered on people with little regard for borders, they should focus on human rights, and the environment.
4. There are five challenges in the region:
   4.1. Unstable governments, economic underperformance, and the spread of instability to other states and regions.
   4.2. Ineffective conflict management.
   4.3. Uncoordinated global development.
   4.4. Ethnic and religious diversity that fuels conflict.
   4.5. Human induced climate change.
5. All of these factors are linked and interact in complex ways.
6. Data already exist so these relationships can be explored. The Political Instability Task Force (PITF) generated instability data; the Minorities at Risk database addresses the level of political and economic discrimination faced by ethnopolitical groups throughout the globe; the Inequality-Adjusted Human Development Index (IHDI) is a useful metric for assessing extreme poverty, effective learning for children and youth, gender equality and social inclusion, health at all ages, and inclusive, productive, and resilient cities; and of course there are now many metrics for monitoring climate change.

Panelist Discussion

Dr. Wilkenfeld asked Dr. Lawson if he could elaborate on self-fulfilling prophecies.

- Dr. Lawson: Our fear of a hostile attack on our digital infrastructure has caused us to take a militarized approach to its defense that may force others to take a similarly military approach, causing everyone to miss opportunities for more cooperative ways of securing the cyberworld.
- LTC Pike: Trying to control everything may be a mistake, democracy lives at the edge of chaos.
- Dr. Wilkenfeld: It is important to remember that there is a complex relationship between regime stability and democracy; autocracies tend to be stable, and it is when they move toward democratic regimes that they become unstable.

Dr. Lawson asked LTC Pike about how to prevent users of models from misusing or misinterpreting their results?

- LTC Pike: Education is essential. As reading was for the common soldier to perform with current technology in World War II, the ability to code is essential for the warfighter to use the tools necessary to fight in the 21st century. Furthermore, users need to build the models themselves so that they understand their limitations.

Appendix: SMA USCENTCOM Black Swan Panelist Biographies

Dr. Claudio Cioffi-Revilla (George Mason University)

Dr. Cioffi is University Professor Emeritus, George Mason University, and an independent scientist and consultant. He received his first doctorate in quantitative political and social sciences from the University of Florence, Italy (1975) and a second Ph.D. in mathematical models in International Relations from the State University of New York (1979). From 1977 to 2019 he taught at UNC Chapel Hill, and held tenured professorial positions at the University of Illinois at Urbana-Champaign, the University of Colorado-Boulder, and George Mason University, where he became the first Professor of Computational Social Science, founding chair of the Department of Computational Social Science, and founding director of the Center for Social Complexity (2002–2019). His research interests include climate and human security, conflict modeling and deterrence theory, disasters and risk analysis, and social complexity theory and research. His current research projects include theory and applied research on multi-scale disasters in coupled human-artificial-natural systems (CHANS), climate change, and advanced formal methods for hybrid functions in complex systems (foundations of nabladot calculus). His research has been supported by DARPA, NSF, ONR, DHS, NCTC, and ODNI, among other agencies. He is a co-founder and first President of the Computational Social Science Society of the Americas (CSSSA), a member of the American Mathematical Society (AMS, operator theory), SSEER (Social Science Extreme Events Research), KSS (Knowledge Systems for Sustainability), and DOD OSD SMA, among other scientific and policy networks. As a Jefferson Science Fellow of the US National Academy of Sciences, he served as Senior S&T Adviser at the US Department of State/INR, and a DNI's Galileo Awards Finalist. He has authored over one hundred peer-reviewed scientific and policy publications, including seven books, the most recent being *Introduction to Computational Social Science: Principles and Applications*, 2nd edition, pp. 600 (Springer,

2017). In 2020 Dr. Cioffi was elected as honorary Fellow of the AAAS (American Association for the Advancement of Science).

Dr. Lawrence A. Kuznar (NSI, Inc.)

Lawrence A. Kuznar (Chief Cultural Sciences Officer, NSI, Inc., Professor of Anthropology, Purdue University-Fort Wayne) conducts anthropological research relevant to counterterrorism and other areas of national security. His research ranges from advanced statistical and geographical modeling of social instability, to discourse analysis of adversaries including North Korea, China, Russia, Iran, and ISIS (Daesh) to provide leading indicators of intent and behavior. He has developed computational models of genocide in Darfur and tribal factionalism in New Guinea, mathematical models of inequality and conflict, and integrated socio-cultural databases for geo-spatial analysis of illicit nuclear trade and bioterrorism. Dr. Kuznar's recent research has been funded by academic sources, the Office of the Secretary of Defense Strategic Multi-Layer Analysis, Air Force Research Lab (AFRL), the Human Social Cultural Behavior (HSCB) modeling program of the Department of Defense, and by the US Army Corps of Engineers. He has also served on the HSCB Technical Progress Evaluation panel and a National Counterterrorism Center (NCTC) net assessment panel. He conducted extensive research among the Aymara of southern Peru and with the Navajo in the American southwest. Dr. Kuznar has published and edited several books and numerous peer-reviewed articles in journals such as *American Anthropologist*, *Current Anthropology*, *Social Science Computer Review*, *Political Studies*, *Field Methods*, and *Journal of Anthropological Research*. Dr. Kuznar earned his Ph.D. and M.A. in Anthropology, and a M.S. in Mathematical Methods in the Social Sciences from Northwestern University. His B.A. in Anthropology is from Penn State.

Dr. Sean Lawson (University of Utah)

Sean Lawson is Associate Professor in the Department of Communication at the University of Utah and Adjunct Scholar at the Modern War Institute at West Point. His research focuses on the relationships among science, technology, and security. In particular, he focuses on the intersections of national security and military thought with new media, information, and communication technologies (ICTs).

His most recent book, *Cybersecurity Discourse in the United States*, explores the use of cyber-doom rhetoric in the U.S. public policy debate about cybersecurity. His first book, *Nonlinear Science and Warfare*, traced the use of chaos theory, complexity theory, and network science in the development of theories of information-age warfare.

Dr. Lawson received his Ph.D. in Science and Technology Studies from Rensselaer Polytechnic Institute in 2008. He has an MA in Arab Studies from the School of Foreign Service at Georgetown University and a BA in History from California State University, Stanislaus.

LTC Tom Pike (United States Army SSI)

Lieutenant Colonel Tom Pike is a Joint qualified, Strategic Intelligence officer in the US Army. Tom is faculty at the National Intelligence University and Co-Director of the Anticipatory Intelligence and Adaptive Influence (AI2) Center. Tom earned his PhD in Computational Social Science (CSS) from George Mason University in 2019. Tom has studied complex systems and its application to foreign policy from the tactical to the strategic level for the past decade and this interest drove him to attend both the CSS PhD program (as the program is based on complex systems) and the prestigious Santa Fe Institute's Complex Systems

Summer School. He has served in the infantry (both light and mechanized) and in military intelligence specialties.

Dr. Jonathan Wilkenfeld (University of Maryland)

Jonathan Wilkenfeld received his Ph.D. in political science from Indiana University in 1969. He has been a Professor of Government and Politics at the University of Maryland since 1969, where he served as chair of the department from 1990 to 2002. He has had periodic visiting appointments at Johns Hopkins University School of Advanced International Studies and in the Department of International Relations at the Hebrew University of Jerusalem. He has lectured at universities in China, Taiwan, Japan, South Korea, Brazil, Argentina, Chile, Germany, France, Sweden, Hungary, Poland, Israel, Dubai, and Egypt.

Wilkenfeld's work has spanned several additional disciplines, including most prominently social psychology and computer science. He has published 12 books on conflict processes, international crises, and conflict resolution, and his research has been published in leading journals in these fields, including *Journal of Conflict Resolution, International Studies Quarterly, Journal of Peace Research, Political Psychology, IEEE Intelligent Systems, and Artificial Intelligence Journal*. His work has been recognized with many awards, including Innovation in Teaching with Technology Award, University of Maryland 2001; American Council on Education/AT&T Foundation Award for Technology as a Tool for Internationalization, 2003; University of Maryland Landmark Award in International Affairs, 2003; International Studies Association Distinguished Scholar Award, 2004, and University of Maryland Distinguished Scholar Teacher Award 2009. In 2008, he was invited to give the keynote address at the annual meeting of the Society for Mathematical Psychology. Wilkenfeld has had research grants from the National Science Foundation (6), US Department of Education (7), US Institute of Peace (3), IBM (2), US Department of Homeland Security (2), US Department of Defense, NCR, Sun Microsystems, Hewlett Foundation, Carnegie (1 each), and the Folke Bernadotte Academy (Sweden).

Wilkenfeld has founded and/or directed some of the leading projects in the field of conflict processes and analysis. These include the Interstate Behavior Analysis (IBA) Project in the 1970s, the International Communications and Negotiations Simulation (ICONS) project beginning in the 1980s through today, the International Crisis Behavior (ICB) Project with Michael Brecher since the mid-1970s, the Minorities at Risk (MAR) and Minorities at Risk Organizational Behavior (MAROB) Projects (founded by Ted Gurr), as well as the Crisis and Negotiations (CAN) Project since the late 1990s. CAN facilitated Wilkenfeld's move into the area of experimental research, bringing to political science some of the methodologies which had heretofore been associated most closely with psychology and social psychology. He has been Director of the Center for International Development and Conflict Management (CIDCM) at the University of Maryland, and he has been one of the principles of the National Consortium for the Study of Terrorism and Responses to Terrorism (START) since its founding in 2005, headquartered at Maryland.

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