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Title:	Examination of the Role of Nuclear Deterrence in the 21st Century: A Systems Analysis Approach
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Abstract

Examination of the Role of Nuclear Deterrence in the 21st Century: A Systems Analysis Approach

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Until very recently, an evaluation of US policy regarding deterrence and the role of its nuclear weapons arsenal as a deterrent has been largely absent in the public debate. With President's Obama embrace of a goal of a future world without nuclear weapons, issues of nuclear policy and deterrence have just recently risen to the forefront of policy discussions. The traditional role of US nuclear weapons—to deter the use of nuclear weapons by other states—endures, but is no longer unique nor even predominant. In an increasingly multi-polar world, the US now faces growing risks of nuclear weapons proliferation; the spread of weapons of mass destruction generally to non-state, sub-state and transnational actors; cyber, space, economic, environmental and resource threats along with the application of numerous other forms of "soft power" in ways that are inimical to national security and to global stability. What concept of deterrence should the US seek to maintain in the 21st Century? That question remains fluid and central to the current debate.

Recently there has been a renewed focusing of attention on the role of US nuclear weapons and a national discussion about what the underlying policy should be. In this environment, both the United States and Russia have committed to drastic reductions in their nuclear arsenals, while still maintaining forces sufficient to ensure unacceptable consequence in response to acts of aggression. Further, the declared nuclear powers have maintained that a limited nuclear arsenal continues to provide insurance against uncertain developments in a changing world. In this environment of US and Russian stockpile reductions, all declared nuclear states have reiterated the central role which nuclear weapons continue to provide for their supreme national security interests.

Given this new environment and the challenges of the next several decades, how might the United States structure its policy and forces with regard to nuclear weapons? Many competing objectives have been stated across the spectrum of political, social, and military thought. These objectives include goals of ratification of the Comprehensive Test Ban Treaty, recommitment to further downsizing of the nuclear arsenal, embracing a long-term goal of the elimination of nuclear weapons, limitations on both the production complex and upgrades to nuclear weapons and delivery systems, and controls and constraints to limit proliferation of nuclear materials and weapons, particularly to rogue states and terrorist groups.

Examination of the Role of Nuclear Deterrence in the 21st Century: A Systems Analysis Approach

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"There can be little doubt that the post-Cold-War world offers a new strategic paradigm for nuclear weapons, and particularly for the concept of deterrence."

—Robert Gates, speech on Nuclear Weapons and Deterrence in the 21st Century to the Carnegie Endowment for International Peace, October 28, 2008.

Background and Introduction

Until very recently, an evaluation of US policy regarding deterrence and the role of its nuclear weapons arsenal as a deterrent has been largely absent in the public debate. With President's Obama embrace of a goal of a future world without nuclear weapons, issues of nuclear policy and deterrence have just recently risen to the forefront of policy discussions. The traditional role of US nuclear weapons—to deter the use of nuclear weapons by other states—endures, but is no longer unique nor even predominant. In an increasingly multi-polar world, the US now faces growing risks of nuclear weapons proliferation; the spread of weapons of mass destruction generally to non-state, sub-state and transnational actors; cyber, space, economic, environmental and resource threats along with the application of numerous other forms of "soft power" in ways that are inimical to national security and to global stability. What concept of deterrence should the US seek to maintain in the 21st Century? That question remains fluid and central to the current debate.

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Given this new environment and the challenges of the next several decades, how might the United States structure its policy and forces with regard to nuclear weapons? Many competing objectives have been stated across the spectrum of political, social, and military thought. These objectives include goals of ratification of the Comprehensive Test Ban Treaty, recommitment to further

1 The views expressed are the author's own and not those of the Los Alamos National Laboratory, Sandia National Laboratory, Stanford University, the National Nuclear Security Administration, the Department of Energy or any other agency.

downsizing of the nuclear arsenal, embracing a long-term goal of the elimination of nuclear weapons, limitations on both the production complex and upgrades to nuclear weapons and delivery systems, and controls and constraints to limit proliferation of nuclear materials and weapons, particularly to rogue states and terrorist groups.

Also of concern is the increasing evidence of neglect of the United States nuclear weapons enterprise and a lessening in an understanding of the role of deterrence in national security. The Defense Science Board Task Force on Nuclear Deterrence Skills (also known as the Chiles commission) recently stated "the perception exists that there is no national commitment to a robust nuclear deterrent," urging "the Administration and senior military leadership, through actions and words, (to) make a concerted and continuing effort to convey to the nuclear weapons community that their mission is vital to the security of the nation and will remain vital." Similarly, the Secretary of Defense Task Force on DOD Nuclear Weapons Management (led by Dr. James Schlesinger) noted that "the concept of nuclear deterrence has receded from the attention not only of the Air Force but also of the national leadership and the general public... (the United States) needs to maintain and, where necessary, modernize it nuclear weapons forces." These concerns have been echoed in the Congressionally charted Strategic Commission on Nuclear Posture, chaired by former Secretary of Defense William J. Perry.

Several influential, bipartisan think tanks have reached similar conclusions. The Center For Strategic and International Studies (CSIS), in a sponsored report "The Department of Defense and the Nuclear Mission in the 21st Century: A Beyond Goldwater-Nichols Phase 4 Report" concluded that "resuscitating the credibility of the US nuclear deterrent in an era of nuclear multi-polarity requires that Washington gets serious about its nuclear strategy, policy, and force posture. Since nuclear weapons belong to the President, leadership on these issues must start at the top."

In April of 2010, the Obama administration released its nuclear posture review (NPR). This document undertook a comprehensive evaluation of nuclear policy and the role of nuclear weapons, concluding that nuclear deterrence remains a central strategy of protecting the supreme national security interests of the United States, while narrowing the role of nuclear weapons in national policy and committing to further reductions in the nuclear stockpile. The 2010 NPR specifically declares that the US while neither threaten or use nuclear weapons against non-nuclear states in good-standing with the Nuclear Nonproliferation Treaty. While this declaration falls short of a full no-first-use policy desired by some in the administration, it does further constrain nuclear weapons as an element of US policy. Clearly, the details of "deterrence" are changing in light of 21st Century requirements, as evidenced by the declaration in the new NPR that the threat of nuclear weapon use by rouge states or subnational groups is at least as much a threat to US security as a Cold-War style nuclear exchange. Just as significantly, the NPR rebalances the components of the US nuclear deterrent away from numbers of weapons and more toward the capability to reconstitute weapons as an insurance policy against technical or geopolitical surprise.

spectrum of options against a comprehensive set of criteria, and employing systems analysis tools to compare between various strategies.

Approach

The authors of this paper comprise a small group of professionals who have spent their careers actively engaged in both the technical and policy aspects of nuclear weapons. This group began meeting in the fall of 2007 to engage in an informal bi-laboratory discussion of nuclear policy issues. Through an evolutionary process, we arrived at an approach that we found helpful in objectively assessing a broad spectrum of deterrence paradigms.

Our underlying intent in this work was to somehow capture the entire "space" of deterrence paradigms in one overarching theoretical framework. Historically, scholarly assessment of deterrence theory usually consist of analysts proposing, advocating and critiquing one particular strategy for deterrence. Each proposed paradigm, if compelling and interesting, stimulates the emergence of a school of supporters and detractors. Our goal was to take a more systems-oriented approach to this analysis, and attempt to asses a broad spectrum of options against common criteria. To the extent possible, we wish to embrace the entire range of possibilities and not promote or emphasize one paradigm over another. In constructing paradigms for assessment, many nuanced differences in the range from nuclear supremacy to a world with zero nuclear weapons exist. We have selected a representative set of seven paradigms to span this space. These are not necessarily an independent spanning set, nor the only options available for analysis. Our goal was a set of options with enough differences to gain insight into how different strategies for achieving deterrence might vary and what the particular strengths and weakness of each were against the different regions of "deterrence space".

Our analytic approach is distinguished by three characteristics. First, it examines a broad spectrum of deterrence paradigms. Second, it provides a framework for individuals with divergent philosophies on nuclear weapons to reach consensus on certain aspects of deterrence paradigms. Third, it applies commonly accepted decision analysis tools to evaluate and compare the different paradigms.

We initially set out to consider US deterrence strategy in terms of its relationship to a variety of national security objectives. Yet, this immediately led to the realization that there is no single, well-understood characterization of US deterrence strategy today. Indeed, US deterrence strategy has evolved over time and been characterized in a wide variety of ways. Furthermore, US strategy continues to evolve and may embark upon any number of future paths. Thus, it was decided to examine a deliberately broad spectrum of deterrence strategies or "paradigms." To this end, bounding cases and intermediate approaches were identified. So, instead of focusing on the attributes of a specific paradigm or comparing and contrasting two paradigms, our approach seeks generality by considering a spectrum.

To capture this spectrum of deterrence paradigms, we postulated two bounds with representative "touchstone" paradigms in between. One end of the spectrum is bounded by what we referred to as "nuclear supremacy." On the other end of the spectrum is deterrence without nuclear weapons, which relies on conventional weapons, diplomatic tools, etc. to achieve the goals of deterrence. Five

more representative "slices" through the space of deterrence paradigms between the bounds were also selected and studied. Known paradigms that have been subject to extensive analysis and discussion both by advocates and critics were chosen to somewhat uniformly span the space between the bounds. It is not our intent to invent new paradigms. We recognize the possibility of taking combinations of existing paradigms as a next step if one were to try to find an optimal paradigm relative to some set of metrics, such as the ones we present here.

One complication of using well-known paradigms is the fact that they may be subject to differing interpretations and that common terms or assumptions may not be agreed upon by all. For this reason we are careful to offer definitions of our terms and assumptions. We have also adopted a common terminology which may conflict with other analysts. Deterrence theory has not adopted comprehensive and agreed set of terms, and it is quite possible that our usage in this work conflicts with other common definitions. Again, we define our terms and assumptions throughout this analysis and welcome suggestions in nomenclature which may improve upon our assessment.

The seven representative paradigms we used are:

- Nuclear Supremacy
- Assured Destruction
- Tailored Deterrence
- Threshold Deterrence
- Capability-based Deterrence
- Virtual Deterrence
- Unilateral US transition to conventional deterrence

These paradigms are defined in detail after a brief discussion of our definition of the term "deterrence".

Deterrent Analysis

Broadly speaking, deterrence is the means by which one actor prevents another actor who is contemplating a certain action from actually carrying it out. Deterrence may be based on punishment or denial or both. Denial involves making an actor recognize that action in pursuit of a goal would be futile for the simple fact that the goal would be unachievable. Denial is passive – i.e., castle walls deter attack by cavalry. Denial can however be overcome by hintr of effort or some new means that is asymmetric to the original design – a castle wall may be breached by artillery or missiles or parachutes. Punishment is based on making an actor recognize that action in pursuit of a goal would result in an unavoidable and unacceptable (to that actor) retaliation with a net and unsustainable loss. Punishment is active – the act of striking back. Punishment can be evaded – a shield may protect against the counter strike or the counterstrike may itself be disarmed.

For purposes of this work we consider only deterrence by punishment. Our working definition will be: Deterrence refers to the threat of punishment if an action sought to be deterred is undertaken.[1] Deterrence by punishment will not necessarily succeed for non-rational actors or for situations in which value systems are not understood – if it is not correctly understood what will constitute "punishment". As commonly understood, deterrence ensures that an adversary does not conduct an act that threatens the fundamental security of the United States or its allies. There are many other subtleties which come into play in this definition of deterrence, including the ability to identify assets to be held at risk, the ability to communicate intentions, and other factors. We refer to the substantial literature in this field for further discussion. In our definition of paradigms and criteria below, we often refer to nuances in this definition of deterrence as can be seen in the individual analysis.

Definition of Paradigms

Nuclear Supremacy

This paradigm is one bookend of our assessed paradigms in which global stability and US national security are achieved through an assertive nuclear posture in which the US is a benevolent "nuclear policeman" for the rest of the world. The philosophy underlying nuclear supremacy is that the world would be better off with very few nuclear capable nations able to achieve parity with the United States and that the sole preeminent arsenal should be under the US government system of checks, balances, and transparency, thereby ensuring that it is held to very high safety and security standards. Under nuclear supremacy, the US would maintain a nuclear stockpile that far exceeds that of any other nation (or any of any combination of nations). In this paradigm, the US would discourage nuclear proliferation through guarantees that it would ensure others' national security through use of its own military might (which could include the nuclear arsenal). If, despite US guarantees, a nation started down the path of developing a nuclear stockpile, the US would use assertive means at its disposal to engage and dissuade this effort. To address nations that already possess nuclear arsenals, the US would encourage these nations to dismantle their arsenals in exchange for the aforementioned US security guarantees and to provide a highly asymmetric nuclear capability against those countries that continued to retain nuclear arsenals. The US might even seek to preemptively destroy these arsenals.

Under nuclear supremacy, the US would maintain a large and diverse arsenal that included a spectrum of capabilities from low yield weapons to destroy elements of a nation's nuclear capability to high yield weapons to hold nations at risk. An expansive deployment of nuclear options would be considered in this paradigm, including tactical and strategic nuclear weapons with both deterrence and warfighting roles.

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[1]Note on nomenclature –Given a pair of actors, the "deterer" seeks to prevent an action by the "deteree".

Assured Destruction

This paradigm seeks to ensure US national security by maintaining a nuclear arsenal capable, even after having absorbed a first strike, of destroying the society of any adversary. It is similar to the Mutual Assured Destruction (MAD) paradigm of the Cold War era. That paradigm asserts that a strategic balance or equilibrium of mutual deterrence is obtained if each of two states possesses the ability to annihilate the other in a retaliatory strike even after having absorbed a first strike; thus, "mutual". Assured Destruction is a more US-centric concept that allows for the US to annihilate an attacking state even if that state has "only" executed a limited, severely damaging but not annihilating, strike on the US. Assured Destruction is not a war fighting paradigm, nor does Assured Destruction consider limited nuclear use. Assured Destruction is a paradigm intended to deter limited or full-scale nuclear attack against the US by ensuring that the consequences of such an attack to any adversary (or any combination thereof) would be unavoidable and unacceptable. Assured Destruction is driven primarily by the existence of nuclear peers for whom the nuclear supremacy paradigm is unsuccessful or unsustainable, but, with whom the US deems it necessary to at least maintain nuclear parity.

Under Assured Destruction the US would maintain a relatively large and survivable arsenal. This arsenal would not be particularly diverse. It would include only those capabilities necessary to overwhelm any enemy defensive systems and ensure destruction of this enemy. This paradigm relies on other means for warfighting and tactical advantage, and nuclear weapons hold a strategic, deterrent role in this strategy. This paradigm works hand-in-hand with conventional forces and other means as instruments of US policy, though the nuclear component is prominent and visible to others, especially those seen as nuclear peers.

Threshold Deterrence

This paradigm is a scaled back version of assured destruction that holds only an appropriate minimum subset of an adversary's assets at risk. The intent of this paradigm is to deter existential attacks without seeking parity with other nuclear nations. The motivations behind threshold deterrence range from pragmatic considerations of the costs of being in an arms race with a determined adversary to a desire to set an example for other nations by deemphasizing the role of nuclear weapons to a bare minimum. Threshold deterrence can be accomplished with a smaller, perhaps single-weapon-type arsenal and a greatly reduced nuclear weapon complex. An example of a state which employs threshold deterrence is the United Kingdom. The UK felt that in holding a specific asset of the Soviet Union at risk, it obtained the value of nuclear deterrence. In this case, the asset held at risk was the Soviet capital, Moscow. This paradigm does not seek parity in the numbers of nuclear weapons against other nuclear states, but places a premium on the survivability of nuclear forces so that any potential adversary is assured of receiving a counterstrike capable of destroying the defined threshold (Moscow in the case of the historic UK strategy). This paradigm relies increasingly on other means such as conventional forces, diplomacy, and economic means to compel policy in its interest.

Tailored Deterrence holds an adversary at risk through a combination of diplomatic, economic, conventional, nuclear, and any other means that are appropriate and effective for the specific

adversary. Tailored deterrence is discussed at length by Bunn (Bunn, 2007). This paradigm includes a careful assessment of each potential adversary, and develops a response tailored to that adversary's circumstance and situation. The spectrum of options from nuclear to conventional, diplomatic, and economic are used to hold specific assets of the adversary at assured risk, gaining the benefits of deterrence in an environment of fewer nuclear weapons and increased understanding which hopefully mitigates crisis management and response. This paradigm has a suite of tools, including effective information gathering which supports the detailed understanding of each adversary, which provides companion benefits to the US. In effect, this approach seeks to "right-size" the deterrent element and response of the US to gain maximum efficiency in deployment of deterrence assets. The nuclear component of this strategy is modest, and contains sufficient excess capacity only to insure against unknown factors such as geopolitical or technical surprise.

Capability-based Deterrence

This paradigm relies on the ability to reconstitute a nuclear arsenal as a form of deterrence rather than a larger arsenal of deployed weapons. This paradigm has received considerable attention, including the adoption of important elements of this strategy in the 2010 nuclear posture review. In sum, capability-based deterrence relies on an agile and sufficiently capable infrastructure that can produce deployable weapons if needed at appropriate capacity. In this scenario, the ability to design, fabricate and deploy a deterrent that meets changing threats is paramount. The majority of deterrence is gained by this capability, though not all. A small (perhaps very small – few hundred) nuclear arsenal is deployed to ensure an immediate deterrent against most potential threats, with the capability of the weapons complex providing the insurance against breakout scenarios, technological surprise, or changes in the geopolitical environment.

The uncertainty and risk in this paradigm are twofold: the uncertainty in timing needed to adequately respond to an emerging threat, and the relative vulnerability of the reconstitution infrastructure to a disabling first strike or other attack. Both of these concerns are addressed in large-measure by the small, deployed arsenal which accompanies a capability-based strategy. Note that this strategy requires a confident, agile nuclear weapons complex. Adoption of this paradigm requires a commitment to ensure this capable reconstitution capability. Where possible, the capability-based deterrence is US centric with minimum dependence on foreign intervention and suppliers. Note that this paradigm requires a strong intelligence program that would allow for timely responses to dynamic threats and to minimize the chance of geopolitical or technical surprise.

Virtual Deterrence

This paradigm emphasizes the availability of parts over a production capability. This is a form of "just-in-time" deterrence with respect to reconstitution of nuclear weapons. As such, it requires a large component stockpile rather than a large assembled stockpile of war heads and an elevated readiness of response. This scenario consists of a large number of plug and play components with robust delivery platforms that are assembled and deployed in time to meet the threat. Similar to the Capability-based deterrence, exquisite intelligence is needed to better understand the threat and provide an adequate defeat response. A decreased readiness posture is required to maintain an

adequate force structure and a vital supporting infrastructure. The difference between this paradigm and a capability-based deterrent is the emphasis on available parts and materials here (e.g., parts over the factory) compared to a capability-focused factory-over-parts approach. In this paradigm, nuclear know-how and expertise is not specifically retained. It is sufficient to document (via blueprints, etc.) the various components and materials needed for a nuclear system, produce most if not all of these in sufficient quantity, and them warehouse them for potential use should the need arise. This paradigm is highly specialized, but we note that Pakistan is likely following this strategy, at least to some degree with its dispersed inventory of nuclear components. The advantage of this strategy is the relatively high standard of safety and security by storage of weapons in this form, along with the lack of infrastructure needed to support maintenance of a nuclear deterrent, which provides some economic and efficiency benefit.

Unilateral US transition to conventional deterrence

This paradigm holds that the US is assumed to have found and implemented a means of deterrence that does not require any nuclear weapons. This paradigm represents the other "bookend" of the strategies which we evaluate. This is much like tailored deterrence with the notable difference that, under this paradigm, the US has entirely foresworn its nuclear arsenal. Moving to this paradigm could be motivated by a US desire to provide leadership on the path to global nuclear disarmament and is predicated on the assumption that US non-nuclear means are adequate to ensure security until this end state is reached. Thus, it would have to be viable even against other states who maintain their nuclear weapons. The US would rely on diplomatic, economic, cultural "soft power" and advanced conventional military means to ensure its national security. We assume that conventional US military capabilities are sufficiently superior and robust that they present a compelling alternate to potential adversaries, including nuclear states.

Note that our definition of this paradigm does not presume a zero nuclear weapons world; only that the US has foregone nuclear weapons. The conclusions we reached, as reflected in the matrices, would of course be different for a universally nuclear-weapons-free world.

Note that our team discussed the possible evaluation of a true world free of nuclear weapons, in which all states had agreed to give up nuclear deterrence. We ultimately concluded that such a world was sufficiently different from the geopolitical landscape of today, that our assessments against the various criteria would entail substantial extrapolation and conjecture, rendering our results highly suspect. Other proponents of a goal of a world free of nuclear weapons have made the same observations, noting that the geopolitical climate today does not allow the immediate adoption of this strategy (ref: William J. Perry, talk on the future of nuclear weapons, Stanford University, Nov. 2009).

Criteria and Assessment

Our approach provides a framework for analysis and discussion of a diverse set of criteria which influences a chosen strategy to ensure security, especially those questions relating to the role of nuclear weapons. Assessment of the relative merits of deterrence paradigms is often a subjective

endeavor that is influenced by the personal views of those doing the assessment. Indeed, much of the deterrence literature advocates for particular viewpoints. To the extent possible, our desire is to take an objective view and provide a framework which can integrate diverse opinions. The criteria below were arrived at after extended discussion within our group. This analysis was a lengthy process that often involved refining definitions and criteria, which usually resulted in a need to reexamine prior criteria and assessments to ensure consistency. Ultimately, we choose 37 criteria which we grouped into 5 broad categories. No fewer than 4 passes through these criteria were needed to ensure consistency in our evaluation, a process which required the better part of a year of our efforts. Even with our careful efforts at consistency, we often found a diverse opinion and failed to achieve consensus for every paradigm. The generality of the objectives and each member's personal philosophy on security, the efficacy of nuclear weapons, and our assessment of the policy and political environments often led each of us to reach different conclusions. To address these issues, we most-often would further refine the objectives and thereby narrow the divergence of our assessments. Ultimately, we did achieve a consensus in both the criteria we evaluated against and in the scores we assigned each paradigm against these criteria. This is far from a perfect evaluation, and other groups may reach a different set of scores and conclusions. None-the-less, we did place a priority on consistency and fairness in our evaluations and hope that our methods and process may hold some value, if not the specific evaluations and the conclusions that we reach.

As a first step, each of the 37 criteria was scored against each of the 7 paradigms. This scoring was performed on a 10 stage constructed scale based on a group consensus for how well the paradigm meets the particular deterrence requirement described by the criteria. The scale chosen is given by E = Exceeds Requirements, M = Meets Requirements, P = Partially Meets Requirements, F = Fails to Meet Requirements. A further discrimination was made allowed by use of a +/- symbol referring to additional gradations for each level (e.g. E+ would be given to a paradigm that greatly exceeds the requirement and E- would be for a paradigm that barely exceeds the requirement.)

Generally, a meets (M) was assigned as a score when the group felt that the paradigm fulfilled the intent of the stated criteria. If the paradigm was particularly effective or efficient in fulfilling the objectives of the criteria, an exceeds (E) score was given. In the case where only a portion of the objective was met, a partially meets score (P) was the result. Whenever a P was assigned, we generally tried to identify both the portion of the paradigm that fulfilled the objective, and the portion which did not. These two aspects of the evaluation for a "P" score are given in the results, below. A fails-to-meet (F) score was given to those paradigms which did not substantially fulfill the objectives of the criteria.

This process of grading criteria against paradigms was lengthy. As previously stated, we found that definitions and assumptions were often key. These definitions and assumptions are given in both the definitions of the criteria (below) as well as in the written text accompanying the scores for each paradigm. In an effort to insure consistency across our evaluation, we often found it necessary to re-address scores, criteria, and definitions from previous evaluations. As stated previously, we made no fewer than 4 complete passes through the entire paradigm/criteria matrix in arriving at the results given below, a process that took more than a year of our collective evaluations and discussion.

Note that the quantitative analysis of our evaluation follows our presentation of the criteria and assessment

Protects Vital US Security Interests

This objective assesses the effectiveness of each paradigm in protecting vital United States national security interests. The overall defense posture of the nation must be taken into account when evaluating how the full spectrum of threats or pressures from without impinges on the full range of the nation's security interests. Threats to US national security interests range from mere nuisances and aggravations to actions that put survival in doubt if we are not strongly defended and they are not decisively defeated. Survival is the most vital national security interest. Today, with the possible exception of economic risks, vital threats are posed by other nuclear weapon forces (or more generally, WMD). We limit our consideration here to that of effectiveness in terms of protecting against credible force-based threats to survival of the US or its security partners (allies).It is recognized that nuclear weapons are only one component of a given deterrence posture. The degree of reliance upon nuclear weapons varies from heavy to none within the various paradigms. For certain classes of national security interests (for instance, those affected by climate change), it is obvious that nuclear weapons will play only a very minor or indirect role (as will all military-type force). As an example, it is probably not plausible that the US would coerce a given nation explicitly by means of its nuclear or conventional force in order to influence that nation's policy on climate change. Still, one cannot ignore the weight of our nuclear force (if we have one) in the overall power balance as other nations interact with the US.

Meets military needs "Military needs" assesses the ability of the paradigm to deter large-scale aggression. Thus, the deterrence posture must be such that, whatever the role (or lack thereof) for nuclear weapons, potential adversaries will not be tempted to become actual aggressors. Nuclear weapons are limited by their very nature in the roles they may credibly be planned to perform. If they are in a state of "latency" then the roles they play are further constrained by considerations of the relative timelines controlling force generation and threat emergence. If a posture relies too heavily on nuclear weapons then, being such blunt instruments, flexibility is impaired.

Meets Military Needs	***Nuclear Supremacy***	E	***Mutually Assured Destruction***	M	***Tailored Deterrence***	E	
	Meets military needs except for those situations for which exploiting nuclear supremacy would be precluded (i.e., those with unacceptable collateral damage).		Advantageous because it prevents large scale wars of attrition. It does so by deterring aggression above a certain level of intensity between MAD parties. Surrogate aggression can still take place however.		This analysis assumes effective tailoring. So, by definition, this paradigm comprehensively meets goals.		
Threshold Deterrence	P	***Capability-Based Deterrence***	M	***Virtual Deterrence***	P	***Unilateral US Transition***	P
Successfully holds the predetermined threshold assets at risk. It is possible that significant targets will fall outside this threshold and, therefore, remain unaddressed. In this case, deterrence might be undermined as the adversary might conclude that it could survive a conflict.		By definition, agility and force structure are in balance against a given adversary.		Militarily effective if response time for assembling deterrence force in a deliverable configuration is timely relative to the threat. Military capability is limited to that provided by the parts inventory. So, some threats might not be addressed.		The ability to hold high-value targets at risk (economic assets, population, power structures) cannot by assured solely by conventional means.	

Assures security partners (extended deterrence) This criteria addresses the paradigm's support of the traditional extended deterrence "umbrella" that the US provides for its allies. This is meant to assure security partners that their survival will not be put in jeopardy by more powerful states so that they will not feel compelled to pursue their own nuclear (or equivalent) deterrence capability. The subtlety here arises when one considers heavy reliance on nuclear force which calls the credibility of the commitment into question; or when there are degrees of latency built in; and especially when the deterrence is by means other than nuclear.

Assures Security Partners (Extended Deterrence)	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	P+	***Tailored Deterrence***	P	
	Assurance of any other state is a given (whether "partner-like" or not). US has nuclear first-strike potential on all other states. US can respond in an environment of diverse psychological "postures" of other states.		Extended deterrence worked with MAD; NATO and WARSAW pact members were mostly assured and therefore did not proliferate. Nevertheless, Unaligned states had more ambiguous security assurances and in some cases proliferated.		Because self-interest dominates US thinking in this paradigm, allies might question the US commitment to tailor its deterrent to their needs.		
Threshold Deterrence	P	***Capability-Based Deterrence***	P	***Virtual Deterrence***	P-	***Unilateral US Transition***	P-
Successful only if the threshold includes those targets deemed necessary by allies to meet their deterrence goals.		Requires significant trust and faith from allies. As the minimum deployed set may not be assuring in and of itself, assurance may require exercising the production capability during an unfolding crisis to augment the deployed force. Allies would have to trust the US to exercise the capability and have faith that it could be exercised in a timely manner.		Deliverable force structures (size and type) are predetermined by inventory of parts. Assuring allies requires a menu of possible force configurations, which may fall outside the scope of a predeployed inventory. Response times for assembling force configurations must be adequate to meet threat timescales.		Assurances depend on the credibility of the US conventional deterrent capability. However, some partners facing other nuclear states may not be assured by US conventional means.	

Unacceptable consequences for aggression (for US and for Allies) These criteria are similar to "meets military needs" but it focuses more on the ability to retaliate should deterrence fail or should aggression arise in regional conflicts. The consequences of retaliation would need to be unacceptable to any (rational) aggressor. These criteria assesses issues of survivability, latency and timeliness, magnitude of punitive destructiveness (as in WMD versus conventional force) and related issues. It also explores the flexibility of and the degree to which partial responses can be employed (if a massive nuclear strike is all the system can deliver then it may not be perceived as credible that it would ever be employed). Other subtle factors arise when we consider delivering unacceptable consequences to aggressions on US allies. Note that this criteria is distinct from the "Defeats adversary if required" criteria in that aggression in this case may not threaten the fundamental security or stability of the United States.

	Nuclear Supremacy E	***Mutually Assured Destruction*** P	***Tailored Deterrence*** M
Ensures Unacceptable Consequences for Aggression (for US)	Magnitude of response is at sole discretion of deterer. An array of potential response assures unacceptable consequence and deters all but fully irrational actors.	Meets goal only if the threat of retaliation is credible. If an adversary's aggression is so great that it warrants massive retaliation, then unacceptable consequences are ensured. Otherwise, the retaliation threat is not credible unacceptable consequences are not ensured.	Because response is tailored to deteree, it is more plausible that it will actually be employed without self-inhibition. Tailoring ensures that the consequences match circumstances.

Threshold Deterrence M	***Capability-Based Deterrence*** P	***Virtual Deterrence*** P-	***Unilateral US Transition*** P
Adversary thresholds can change over time or may be misconstrued or underestimated from the start. Driven by adversary with highest threshold but qualitative nature of thresholds may differ between adversaries: must work for "union" of all adversaries.	Effective lead-time is only as good as the intelligence capability. The timeframe for response is inversely proportional to existing capacity. Unacceptable consequences could be assured, if these timescales matched the threat.	The timeframe for response is constrained by assembly time; options for response are limited by existing parts inventory.	Conventional forces and other non-nuclear means of deterrence are incapable of absolute destruction (or holding survival in doubt). If unacceptable consequences equates to absolute destruction (holding survival in doubt), then deterrence without nuclear weapons fails. From a counterforce perspective conventional forces cannot hold all assets at risk.

Ensures Unacceptable Consequences for Aggression (for Allies)	*Nuclear Supremacy* M	*Mutually Assured Destruction* P	*Tailored Deterrence* E
	Nuclear coercion can suppress aggression between all other states. Extended deterrence umbrella covers all other states.	Assuring unacceptable consequences for aggression against an ally by the most capable other NW state is problematic because it could lead to escalation and would test resolve.	If the US includes security partners interests in what is "tailored", unacceptable consequences are assured by definition.

Threshold Deterrence P	*Capability-Based Deterrence* P-	*Virtual Deterrence* P-	*Unilateral US Transition* F
Threshold finely tuned to given deteree; therefore, nuclear force may be insufficient for extended deterrence.	The minimal deployed set would be insufficient to support extended deterrence concepts. Multi-party dynamics can evolve more rapidly than capability. So, intelligence is more critical with multiple parties.	The response timeline could be challenging if it became necessary to support for multiple allies. Furthermore, assurance options are constrained by the existing parts inventory. Conventional capability may partially compensate for this shortcoming.	Not plausible that conventional force will be able to overcome asymmetry if facing nuclear forces. If whole world is denuclearized then symmetry makes it more plausible; but adversaries would likely seek asymmetry.

Discourages adversary's will to develop parity (dissuades) Dissuasion is the demoralizing, discouraging, dispiriting, de-energizing effect that is created within an aspiring adversary when it perceives itself on the losing end of an insurmountable gap in capability or force-in-being relative to the US. To be dissuasive, the US deterrence posture must not be too finely tuned to a given adversary. It must be somewhat oversized relative to the most powerful of the less-powerful states (the ones that are not already peers or near peers). If a state seeks to obtain dissuasive superiority over a peer then an arms race ensues. This criterion explores the US posture relative to less-powerful states, not peer states that already have parity. It assumes that having a world with fewer peers is more stable than one having many peers. Some have argued that a world with a dominant dipole structure (two peers who tower over the rest of the world; i.e., during the Cold War and to some extent still today) is a particularly stable configuration. Again, this is a question for further research.

Discourages Adversary's Will to Develop Parity (Dissuades)	*Nuclear Supremacy* E	*Mutually Assured Destruction* P	*Tailored Deterrence* M
	Total dissuasion because of the huge disparity between the supreme NW forces of the US and those of all other states.	This paradigm fails as evidenced by the Cold War arms race. This paradigm does dissuade non-peer aspirants.	Parity is not well-defined here and motivation for adversary to seek parity is diffused since tailoring has many more aspects than just size of force. Seeking parity in all aspects may be sub-optimal. Deterrence posture is finely tuned (resonant) to an adversary but the mirror image of it may be "out of tune" (off resonance) against the US.

Threshold Deterrence F	*Capability-Based Deterrence* P	*Virtual Deterrence* P	*Unilateral US Transition* F
May tempt near-peers to break out due to the sizing of the nuclear force to the threshold of the main adversary. Parity is irrelevant to the main adversary who enjoys, by definition, nuclear superiority relative to the deter.	Problematic because minimal deployed force implies the parity differential has been reduced, which may motivate parity-seeking. Parity on the capability side is less well-defined and could spark a "factory race" or competition in science and technology. Overconfidence of adversaries may tempt them to build up, assuming they have same capability as US.	Timeline to respond becomes the only obstacle to an adversary seeking parity with our fixed parts inventory.	Adversary may be dissuaded from seeking non-nuclear parity. Since nuclear parity is achieved with zero weapons, adversaries seeking nuclear superiority will not be dissuaded. When several adversaries acquire a nuclear weapon, the advantages of doing so will be seen by others who may follow suit.

Defeats adversary decisively if required This criteria deals with the possibility that the US may have to force an adversary to capitulate. It is somewhat similar to the ability to deter by means of guaranteed retaliatory (second strike) capability. The difference is that retaliation is meant to create a situation in which there is no rational incentive for a large-scale attack or else to punish fatally if the attack actually occurs (lose-lose state of affairs). The ability to defeat decisively treats the cases where hostilities have begun, at whatever scale and for whatever reason, have become intolerable and must be terminated, in short order and on terms favorable to the US. This is not war fighting; it is war ending. This criteria examines those threats which may call into question the stability or supreme national interest of the US.

Defeats Adversary Decisively if Required	***Nuclear Supremacy*** E	***Mutually Assured Destruction*** M	***Tailored Deterrence*** M
	Defeats adversaries decisively by means of overwhelming NW response, at discretion of US.	Does so by definition but only at the cost of self-defeating mutual destruction.	Assuming tailored deterrence incorporates a nuclear component, the adversary can be defeated decisively in case deterrence fails.
Threshold Deterrence F	***Capability-Based Deterrence*** P	***Virtual Deterrence*** P	***Unilateral US Transition*** P
The asymmetric advantage of the adversary dominates the US. Destruction of threshold may destroy the adversary as a viable social entity but not as a viable military force. Surviving nuclear weapons would likely be used against the US.	If an adversary is undeterred, the minimal deployed nuclear force would come into play. The production capability could enable augmentation of the deployed force if there is sufficient lead time.	Meets goals if the response to the threat is timely and the force provided by the inventoried parts is sufficient to decisively defeat the threat.	As evidenced by World Wars I and II, conventional weapons cannot assure capitulation of powerful non-nuclear adversary absent a large-scale war of attrition.

Counters nuclear threat of other countries One of the purposes of US nuclear forces today is to deter the use of nuclear forces by other states. It is considered credible that US nuclear forces actually do deter other nuclear forces. But credibility depends on force structure or "posture": number, capability, alert level, survivability and so forth. It is not obvious that postures with significant degrees of latency, or having few or no nuclear weapons would be as credible. That is what this criteria addresses.

Counters Nuclear Threat of Other Countries	*Nuclear Supremacy*	E	*Mutually Assured Destruction*	F	*Tailored Deterrence*	P
	Nuclear superiority confers a first strike potential against all other states, even states with NW.		Does not negate or eliminate the threat posed by counterparties NW forces, even under conditions of mutual deterrence.		For non-peer threats tailoring provides credible response options (assuming good intelligence on these threats). Tailoring to a peer NW adversary may lead to a MAD posture.	
Threshold Deterrence	P	*Capability-Based Deterrence*	M	*Virtual Deterrence*	P	*Unilateral US Transition*	P-
Fails unless nuclear weapons are specifically targeted as the "threshold". Yet, because nuclear weapons might not be compelling threshold for the adversary, this paradigm tends to be countervalue. If the adversary's nuclear weapons did survive, they would likely be used against the US.	This paradigm assumes timely detection and response and that near-peers will be deterred by the US minimal deployed nuclear force. For adversary nuclear forces that are surging, the capability base must respond on a relevant timescale.		Succeeds if the adversary is also in a virtual mode, or can be delayed by some other means, such that their response timeline is essentially as slow as ours.		In this paradigm, countering nuclear threats requires highly-capable non-nuclear defense and/or counterforce. Deterrence of potential nuclear threats by conventional means alone is a highly questionable proposition.	

Provides maximal flexibility in response For any given deterrence posture (paradigm) one can expect over time any number of different tests to be levied upon it. The world is turbulent and various forces are always impinging on US national security. A posture which must remain impassive and aloof to all but the most egregious of insults is not flexible and may tempt aggressors to challenge US interests to the perceived threshold that would at last goad the US to strike back. For this reason it is thought that the US should have a "full spectrum" deterrence posture. Even though the primary purpose is to deter threats to US survival due to peers, it must also deter rogues, sub-state actors, irrational and unauthorized behavior. A menu of options allows the US to deter all actors, regardless of status.

Provides Maximal Flexibility in Response (Menu of Options)	***Nuclear Supremacy***	E	***Mutually Assured Destruction***	F	***Tailored Deterrence***	P	
	Menu of military response options is maximal. Includes any possible conventional response, backstopped by nuclear supremacy as well as any chosen level of nuclear response up to total destruction of adversary. May limit diplomatic responses however.		Does not preclude conventional response but constrains it so as not to trigger adversary MAD response. Nuclear response is MAD or nothing. Overarching risk of mutual annihilation constrains space of options for any type of response.		An initial assessment defines the threat space that specifies the necessary degree of response flexibility. Tailoring must be able to evolve on relevant timescales to maintain a good fit to the adversary. Timely adaptations may be possible, given adequate real-time intelligence and advance warning.		
Threshold Deterrence	F	***Capability-Based Deterrence***	E	***Virtual Deterrence***	P	***Unilateral US Transition***	F
Against the adversary with the most demanding threshold the only option is to attack the elements that define that threshold. Against lesser adversaries there may be other options. However, thresholds are defined by more than simply the number of weapons required (nature of targets, defenses, etc.).		Flexibility is a strength of capability-based deterrence. There is no need to guess correctly *ab initio* assuming the capability base responds on the relevant timescale.		Stockpile mix could provide variety of adaptable capabilities assuming the parts were designed accordingly and the systems were designed to be modular.		When facing adversaries with mixed nuclear and non-nuclear capabilities, the US has only non-nuclear responses. Adversaries can exploit this asymmetry to limit US options. Thus, the US response is over-constrained relative to that of adversaries.	

Enhances US Standing/Reputation This subset of criteria includes those factors that influence international perceptions of the US include ratification of the CTBT, reductions in deployed warheads, meeting commitments under the nonproliferation treaty (NPT) and irreversible dismantlement of excess warheads. If the US were to seek to transition itself to conventional deterrence, rather than nuclear deterrence, this might be seen as enhancing US standing internationally while maintaining national security. Diplomatic negotiations are part of this international security strategy. Other scenarios include significant downsizing of delivery platforms and sharing of nuclear energy/weapons information with other countries. This encompasses the current international NPT thought and continues the US process of meeting the ultimate objective of the NPT of a zero nuclear stockpile.

Positively influence international perception of the US This criterion attempts to measure how the international community would perceive the US if it were to base its deterrence on a given paradigm.

Positively Influence International Perception of the U.S.	*Nuclear Supremacy* F	*Mutually Assured Destruction* F	*Tailored Deterrence* E
	US would likely be seen by many as an arrogant bully in the attempt to assert nuclear hegemony.	The US view of itself as a responsible global protector against a single, identified global threat is not shared by others.	This allows effective responses to a wider array of threats from a wider array of adversaries, and the move to nuanced and often non-nuclear response to threats will demonstrate restraint and have positive influence.
Threshold Deterrence P	*Capability-Based Deterrence* M	*Virtual Deterrence* M-	*Unilateral US Transition* M-
World perceives favorably the goal of holding only a minimal set of targets (not all possible targets) at nuclear risk; and, the international community has some ability to influence what assets are considered valuable to the US as targets.	This would have a positive influence only if it were used as an enabler for other actions and policies (e.g. stockpile reductions).	This would be seen positively as a move away from deployed forces and toward a more latent deterrent.	Unilateral US nuclear disarmament would be very favorably viewed by many states. Other states currently under extended US nuclear deterrence may feel the US has abrogated its commitments. However, a highly capable conventional US deterrent may be perceived as more dangerous because of the lower threshold for use.

Meet NPT commitments How well does a deterrence paradigm support negotiation and implementation of stockpile reductions, a commitment to article 6 (ultimate elimination of nuclear weapons), verification methodology and technique, and improved accountability of fissile material, components, and warheads by those countries that participate in the NPT.

Meet NPT Commitments (U.S.)	*Nuclear Supremacy* F	*Mutually Assured Destruction* F	*Tailored Deterrence* P
	This paradigm ignores NPT commitments.	This paradigm ignores NPT commitments.	This paradigm is consistent with meeting NPT commitments in that it seeks stockpile reductions through the replacement of nuclear weapons with other means. That said, it does not foreswear nuclear weapons.
Threshold Deterrence F	*Capability-Based Deterrence* P+	*Virtual Deterrence* F+	*Unilateral US Transition* E-
Even holding a "minimal" target set at risk still constitutes a reliance on nuclear weapons in a stand-alone role with no possibility to vector to lower numbers.	This paradigm is consistent with meeting NPT commitments in that it seeks stockpile reductions through the development of a robust development and production capability. That said, it does not foreswear nuclear weapons.	Lack of a path to eventual disarmament is a hindrance in this paradigm. Parts inventory maintained as the core deterrent.	US will have accomplished a major milestone and provided leadership in pursuit of the NPT goal of nuclear disarmament.

Support US values Does the paradigm promote US social and cultural values such as social justice, freedom, support for democracy, and equality. Many countries do not

value/recognize Western culture; causing a clash of religious values and political and economic philosophy/doctrine.

Support U.S. Values	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P	***Tailored Deterrence***	E	
	This doesn't appear to take the moral high ground and is inconsistent with promotion of democratic values around the world.		MAD was a purely deterrent strategy, not a warfighting strategy - it is purely a war avoidance strategy with a very high threshold for use. Avoidance of large-scale conflict supports US values. Conflicts did occur under MAD; these were limited to proxies because of MAD.		The debate around which threats are met by which means must occur in an open way. A feature is minimizing collateral destruction, which is compatible with US values.		
Threshold Deterrence	M	***Capability-Based Deterrence***	M	***Virtual Deterrence***	M	***Unilateral US Transition***	M
Many of the same reasons as for Tailored deterrence, but the difference is that here, it's still primarily a nuclear option.		The inherent time delay allows greater opportunity for debate and due process about US values - a potential moderating effect on action beyond the immediately available deployable set. However, has the US lost some options for projecting/supporting its values?		Time delay encompasses an even greater potential benefit, because of lack of an immediately available deployable set. However, has the US lost some options for projecting/supporting its values because of the lack of immediacy?		It would be perceived by some US citizens as unjust and risky if the US gave up its nuclear deterrent while other states retained theirs. Democratic states that relied on US extended nuclear deterrence may be vulnerable to coercion by autocratic powers. Superiority of US conventional forces would be seen by some as contradictory with the value of equality, internationally. Others US citizens may view nuclear disarmament as being supportive of US values and furthering the cause of general and complete disarmament	

Be non-provocative to the global community Assesses the degree to which the US is non-provocative toward other states and allies for a given deterrence stance. Given that deterrence should operate "in the background" and is intended to deter acts of aggression against the US and its allies, it would be unfortunate if the deterrence posture in fact encouraged aggression due to provocation and the fear that would be engendered.

	Nuclear Supremacy	F	***Mutually Assured Destruction***	M	***Tailored Deterrence***	P
Be Non-Provocative to the Global Community	Very provocative - "absolute power corrupts absolutely" - too US-centric. The nations of the world may cower beneath the everpresent threat of destruction should the US see fit to strike.		Provocative because of huge potential collateral effects to non-involved states if ever used but less provocative in a general sense since it denounces large-scale war-fighting. The existence of the MAD force is not provocative to all since it is not viewed by all as credible that it would ever be used.		may be more provocative since it's more credible; may be less provocative since it implies a willingness to use less blunt means, i.e. economic sanctions or cultural isolation	

Threshold Deterrence	P	***Capability-Based Deterrence***	E	***Virtual Deterrence***	P	***Unilateral US Transition***	M
It is deliberately and clearly geared to specific, limited threats and targets.		The minimal deployed NW force will be less overtly visible or immediately threatening and will be masked by the capability base which is diffuse and non-provocative.		Is provocative if it can become an assembled weapon more rapidly than another country can take action		Historically, many bystander states have felt threatened by NW. Unilateral US nuclear disarmament would reduce their level of concern relative to the US. However, nuclear disarmament is not sufficient to achieve a non-provocative US stance relative to the global community. Conventional forces of the future (e.g. space weapons, near-instantaneous) could be as threatening as NW. US intentions may be perceived as provocative independent of its deterrence posture.	

Support our current diplomatic objectives and commitments Does the deterrence paradigm provide an amicable relationship with allies and other countries in order to maintain US diplomatic objectives and commitments toward a democratic society and world. This may include increased financial or other aid for those countries economically and socially in need.

	Nuclear Supremacy	F	*Mutually Assured Destruction*	P	*Tailored Deterrence*	M
Support our Current Diplomatic Objectives and Commitments	Diplomacy will be of diminished importance. The US will have no understandings with other states that could not be unilaterally abrogated; thus, no real commitments. There will be no motivation for US to exchange any technical information, even with allies; the concept of allies will be of limited significance.		NATO never really believed that we would trigger Armageddon on their behalf - that's why we had to put tactical weapons in Europe; however, we did support a nuclear umbrella for our allies.		Close collaboration with allies will be required. The careful assessment of threats provides better understanding and insight into allies and adversaries alike which is beneficial to diplomatic initiatives.	

Threshold Deterrence	P	*Capability-Based Deterrence*	M	*Virtual Deterrence*	M	*Unilateral US Transition*	P
Tailored deterrence does not depend upon a careful assessment of adversaries beyond the threshold to be held at risk. As such, this option is relatively inflexible and does not rely upon coordination with allies and other impacted parties.		Assessment of timing of threats is contingent upon allies' data and analysis as well as our own - such collaboration should enhance the effectiveness of this paradigm. Collaborations in sharing capability here even have the possibility of excelling (deepens ties, draws from larger capability pool).		Having the weapons in parts allows opportunities for signaling without immediately resorting to employment, thus opens up additional options to resolve problems diplomatically; however, "coercive" diplomacy options may be more limited		A range of diplomatic options are eliminated when US NW no longer exist (e.g., NATO alliance diplomacy; diplomatic efforts to keep Japan a non-NW state). Elimination of US NW will support certain diplomatic objectives but others, such as the US commitment to provide extended deterrence, may be undermined. Absent NW the US may not be able to counter the formation of a NW-armed bloc. Diplomatic initiatives in nonproliferation would be.	

Maintain pre-eminent national technical capabilities Will the deterrence paradigm provide the US with the means to continue with technical research in the nuclear field including weapons, medicine, and energy and not necessarily share the technical nuclear weapons information with the rest of the world? Expanding the use of nuclear energy, which involves fuel enrichment and reprocessing, increases the risk of nuclear proliferation. Perhaps, if the nuclear countries such as the US, UK, and France provided more enriched fuel to other countries' reactors, this tactic would promote the expansion of nuclear energy without significantly increasing the risk of nuclear terrorism and proliferation.

Maintain pre-eminent national technical capabilities	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	M	***Tailored Deterrence***	M	
	There may be less need for intelligence capabilities, given the absolute capacity for punishment of any aggressor. Nuclear technical expertise may be enhanced but at the cost of less emphasis on other technologies.		The delicate balance of the MAD paradigm requires accurate real-time awareness of the adversary. This imperative tends to support and hone intelligence capabilities.		Reliance on a broader suite of capabilities that are tailored to threats would require intelligence capabilities in many dimensions. High confidence in the accuracy of assessments of adversary intentions and capabilities would be required.		
Threshold Deterrence	M	***Capability-Based Deterrence***	M	***Virtual Deterrence***	E	***Unilateral US Transition***	M
Highly capable intelligence will be required in general to identify what targets are most highly valued by a given adversary. Identifying unknown yet relevant threshold targets is a demanding intelligence activity necessary to support this paradigm.		By definition, both technical and intelligence capabilities must be continuously exercised. Intelligence must provide advance notice of emerging threats on a timescale commensurate with the capability response time.		Intelligence capabilities must be able to see emerging threats and trends far into the future because of the lack of a robust infrastructure. If the virtual capability inherent in the parts inventory is insufficient to meet an emerging threat, then infrastructure, which involves a long lead time, must be improved or built		To be credible, conventional deterrence will require augmentation of intelligence capability. Nuclear attribution expertise must be supported in the absence of synergy with ongoing NW programs in order to satisfy the criterion.	

Benefits Society - Criteria evaluated in this subcategory refer to general benefits and desires to enhance economic prosperity, advance technology, and enable the benefits of nuclear power, medicine, and industrial production.

Enable Beneficial Use of Nuclear Technology

Specifically looks at the degree to which a paradigm is able to produce safe and secure nuclear power, provide essential material for nuclear medicine, and supports a variety of other uses for nuclear technology in industrial settings. Historically, technology transfer from the weapons program has aided these areas, and expertise in subject areas such as nuclear materials and modeling of critical nuclear systems is applicable in both weapon and non-weapon applications.

Enable Beneficial Use of Nuclear Technology	***Nuclear Supremacy***	E	***Mutually Assured Destruction***	P	***Tailored Deterrence***	M
	The benefit of this paradigm is that is precludes nuclear proliferation concerns associated with the global spread of nuclear energy. The potential punitive power of nuclear supremacy would prevent abuse of global nuclear power for nuclear proliferation purposes.		This paradigm relies on a nuclear expertise that has beneficial applications. Nevertheless, it impedes the beneficial use of nuclear technology by stigmatizing nuclear power. An element of MAD is fear of the destructive potential of nuclear weapons. This fear tends to extend to nuclear power.		This paradigm retains potentially beneficial nuclear technology and expertise. Yet, it avoids inciting fear of things nuclear by lowering the salience of the weapons.	
Threshold Deterrence	P	***Capability-Based Deterrence***	P	***Virtual Deterrence***	P	***Unilateral US Transition***	M
This paradigm retains potentially beneficial nuclear technology and expertise. Nevertheless, by overtly holding a threshold set of assets at risk, it tends to incite fear of things nuclear.		This paradigm retains potentially beneficial nuclear technology and expertise. Nevertheless, its robust and vibrant weapons design and production ability tends to engender fear of things nuclear.		Virtual nature of this paradigm provides only limited support for nuclear technology (beneficial or otherwise).		Without a nuclear weapons program nuclear technology would engender less fear stigmatization than it would under a weapon paradigm. Furthermore, nuclear expertise would be applied solely to beneficial (i.e., peaceful) programs.	

Creates a win-win versus "zero-sum" future Evaluates the relative increase in stability and prosperity of the US and the world versus the risk or concerns of negative outcomes from proliferation or coercion associated with asymmetric positions. Included in this evaluation is the relative risk of non-nuclear conflicts and the temptation by states to gain advantage at the expense of others.

Creates a Win-Win versus a "Zero-Sum" Future	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P	***Tailored Deterrence***	M	
	By threatening nuclear punishment the US could suppress the aggressive tendencies of the rest of world. Other nations would feel vulnerable to US caprice. US alone would bear the burden of maintaining global stability and would not have any allies in the traditional sense. Acting alone could deform US "personality" in negative ways. Underlying resentments and conflicts between other states could not be worked out openly and honestly; the rest of world could come to rely on US to make security-related decisions for them; states would be "infantilized".		Avoided major war, but at great risk, MAD disincentivizes large-scale conventional wars of attrition between major powers. There is constant risk of large-scale nuclear conflict resulting from panic, misunderstanding, accidents or unauthorized actions. Proxy wars are fought on behalf of the MAD counterparties. Relations with allies are subtle, complex and at times incredible when placed in a MAD context. Actions of allies can drag major parties to nuclear conflict.		Relies more on international cooperation - less unilateral - more flexible - structure is more sensitive to needs of broad community of states. Because it provides more modalities ("degrees of freedom") there is more flexibility and the potential for significant reliance on international cooperation. It is a less unilateral posture so the deterrence structure can be more sensitive and responsive to the needs of a broad community of states.	
Threshold Deterrence	P	***Capability-Based Deterrence***	P	***Virtual Deterrence***	P	***Unilateral US Transition***	P-
Some allies may no longer be assured - there is no umbrella left. May embolden others to become a nuclear peer.		Realistic response timeline must be achieved to allow "win-win" - for all parties involved - for any threat. Can't go to this state unilaterally. This was part of our overall Cold War paradigm.		Less chance of an accident, i.e. higher crisis stability - because it implies a longer timeline required for response to a perceived threat. More reliance on conventional, however. This could encourage conventional arms races; or, could encourage others to go nuclear.		Highly unstable paradigm means great risk; and, in theory, total reliance on conventional means for deterrence would be even more expensive. To counter even small nuclear forces would require highly capable conventional forces. US security partners, lacking US nuclear assurances, may proliferate. Other States will look positively on US nuclear disarmament. This could increase pressure on all NW states to reduce their nuclear forces. But it would not create the incentives for States who view the US as an adversary to undertake nuclear disarmament.	

Economic, Societal/Cultural Benefits (US and Rest of world) Examines secondary impacts of the development and deployment of various deterrence options. Economic benefits include reduced cost of maintaining security, both within the nuclear weapons program and in other deterrence means such as conventional. Societal and cultural benefits include reduced stress and fear of war, improved trust, and enhanced cooperation among countries.

Economic, Societal/Cultural Benefits – U.S.	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	P	***Tailored Deterrence***	P+	
	Reduced emphasis on militarism and defense issues if supreme nuclear forces were effectively, affordably and quietly maintained in the background. Social and cultural dividends could result from reduced insecurity. Cost efficiency of nuclear versus conventional forces would provide an economic advantage. Impetus for diverse technological innovation driven by pursuit of conventional forces would be lost; nuclear force would be a "monoculture".		Over-hanging threat of annihilation -- Air raid sirens and "Duck and Cover" drills for school children, for example -- create a helpless, fearful and fatalistic mindset in populations. Society and culture are deformed by awareness of danger that pervades social consciousness. Could be economically beneficial if less costly to deter a major power than by other means.		Many different technologies could be called upon to play a role deterrence and would thus be somewhat "militarized." This may be more expensive across-the-board (opportunity cost could be substantial).	
Threshold Deterrence	M	***Capability-Based Deterrence***	P	***Virtual Deterrence***	P	***Unilateral US Transition***	F
This will be economically advantageous due to the reduction in nuclear force structure and required supporting infrastructure.		Economic benefits unclear - may be very expensive to always strive for "best", "newest" technology. Less reliance on nukes is a societal "wish", and this has that seeming attribute. Loses, however, a tangible element of the "big stick".		May be an economic burden, due to reliance on conventional forces over nuclear. May have more comfort in knowing there's less chance of inadvertent NW use. Unstable because it requires a constant level of precise intelligence.		Total reliance on conventional forces would be an economic burden. Other means of deterrence could mean greater dependence by US on others for US national security, and greater global instability. Conventional deterrence may simply be implausible in the face of NW forces of other States.	
Economic, Societal/Cultural Benefits - Rest of World (ROW)	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P	***Tailored Deterrence***	P	
	"Absolute power corrupts absolutely." Improvement or worsening of conditions for ROW would depend solely on how US chose to use its power. If US were to be corrupted and were to coerce and threaten other nations with nuclear strikes it would be a deeply negative factor.		If used, large nuclear MAD forces have widespread collateral effects harmful to ROW. Fate of other nations is held hostage to actions of major nuclear powers. Deformation of behavior of major powers caused by MAD posture may harm economic prospects of bystander states. Surrogate (proxy) wars and conflicts are carried out on behalf of major parties to the detriment of other states. Insecurity engendered by large MAD forces which could easily be re-targeted on them to stimulate other states to increase expenditures for defense.		ROW will have to share the burden and "negative press" (i.e. opportunity cost to them) because there is less reliance on the US and deterrence is less US-centric for friends and allies.	
Threshold Deterrence	F	***Capability-Based Deterrence***	P	***Virtual Deterrence***	F	***Unilateral US Transition***	P
Must now share or shoulder burden of threats to them that aren't covered by U.S. threshold. This could stimulate technological innovation and economic payoffs could result. There would be opportunity costs to ROW if defense efforts came at expense of other productive activities. Spinoffs might partially compensate these costs.		ROW would tend to support smaller stockpile, however, the US rarely gets credit for lower stockpile numbers. Little impact from most states' perspective. May provide a "warm-fuzzy" to other P-5 states, however, may be "arms race" unstable.		Does not provide a national security comfort level between neighboring states because of imprecise intelligence capabilities, or, because they might have less confidence in the ability of a US conventional umbrella to protect them.		US can no longer be the guarantor of others' security with NW. States currently under US extended nuclear deterrence will reassess their own need for an independent deterrence. US will be seen as advancing the cause of NPT Article VI, which will be seen as a positive factor by many States.	

	Nuclear Supremacy F	*Mutually Assured Destruction* P	*Tailored Deterrence* P
Economic, Societal/Cultural Benefits - Rest of World (ROW)	"Absolute power corrupts absolutely." Improvement or worsening of conditions for ROW would depend solely on how US chose to use its power. If US were to be corrupted and were to coerce and threaten other nations with nuclear strikes it would be a deeply negative factor.	If used, large nuclear MAD forces have widespread collateral effects harmful to ROW. Fate of other nations is held hostage to actions of major nuclear powers. Deformation of behavior of major powers caused by MAD posture may harm economic prospects of bystander states. Surrogate (proxy) wars and conflicts are carried out on behalf of major parties to the detriment of other states. Insecurity engendered by large MAD forces which could easily be re-targeted on them to stimulate other states to increase expenditures for defense.	ROW will have to share the burden and "negative press" (i.e. opportunity cost to them) because there is less reliance on the US and deterrence is less US-centric for friends and allies.

Threshold Deterrence F	*Capability-Based Deterrence* P	*Virtual Deterrence* F	*Unilateral US Transition* P
Must now share or shoulder burden of threats to them that aren't covered by U.S. threshold. This could stimulate technological innovation and economic payoffs could result. There would be opportunity costs to ROW if defense efforts came at expense of other productive activities. Spinoffs might partially compensate these costs.	ROW would tend to support smaller stockpile, however, the US rarely gets credit for lower stockpile numbers. Little impact from most states' perspective. May provide a "warm-fuzzy" to other P-5 states, however, may be "arms race" unstable.	Does not provide a national security comfort level between neighboring states because of imprecise intelligence capabilities, or, because they might have less confidence in the ability of a US conventional umbrella to protect them.	US can no longer be the guarantor of others' security with NW. States currently under US extended nuclear deterrence will reassess their own need for an independent deterrence. US will be seen as advancing the cause of NPT Article VI, which will be seen as a positive factor by many States.

Lowers Nuclear Risks

This subset of criteria looks at the risk entailed in maintaining each paradigm for accidents, proliferation, misuse, and other potential negative consequences. The current deterrence posture of the major nuclear powers entails a certain inherent degree of risk due to accidental, unauthorized or unintentional use of nuclear weapons. While some argue that the force structure is inherently safe, others worry that alertness levels are still too high and that there may be a degree of crisis instability in the system. There is also the risk of nuclear accidents; whether involving weapons or components themselves, or involving nuclear materials. If, for example, the US based its deterrence on conventional forces, there would be no associated nuclear risks but there could be other types of risk. Taken as a general proposition that lower risk is to be valued this national security objective evaluates how well a given paradigm lowers risks, of all types.

De-incentivize/prevent nuclear proliferation (horizontal and vertical) Considers whether a deterrence paradigm provides credible means to limit both horizontal and vertical proliferation. Horizontal proliferation refers to the pursuit of nuclear capability by states or actors not otherwise entitled to it under international norms, and vertical proliferation refers

to the increased sophistication of capability available to states or actors that already have nuclear programs.

De-Incentivize/ Prevent Nuclear Proliferation - Horizontal	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P	***Tailored Deterrence***	P+	
	The expanded role of NW demonstrates an intrinsic value that other states may desire to replicate. This incentivizes pursuit of NW, though they would have an asymmetric role in comparison to the superior arsenal.		The expanded role of NW demonstrates an intrinsic value that other states may desire to replicate. Nevertheless, security assurances allay concerns of many allies. Also, evidence of restraint and arms control between the MAD partners might influence potential proliferants.		The inherent restraint in the tailoring process will have positive influence on some would-be proliferators. Extended deterrence guarantees to allies will reduce proliferation, will be less motivated to pursue nuclear weapons, but only if tailoring is perceived to be address their concerns.		
Threshold Deterrence	P	***Capability-Based Deterrence***	P+	***Virtual Deterrence***	P	***Unilateral US Transition***	F
Accomplishes deterrence of targeted state with minimal NW. Encourages non-target states to exploit asymmetries and potentially rival or exceed the established threshold.		Reducing stockpile size influences states supporting normative nonproliferation regimes (signatories of NPT versus non-rogues). It could drive a "factory arms race". It may not influence the actions of regional pairs of adversaries. Allies remain under security assurances provided the capability is credible.		Reducing NW to parts influences states supporting normative nonproliferation regimes (signatories of NPT versus "rogues"). Crisis stability and non-threatening posture is conducive to lowering incentive to proliferate. Relative inflexibility of this paradigm provides fewer options to allies and security partners in the event of a crisis or unforeseen development.		Incentivizes some states to acquire an asymmetric means of countering US conventional forces - these means include nuclear weapons. Furthermore, conventional extended deterrence may not be credible to allies and former nuclear security partners, so they might also seek NW.	

De-Incentivize/ Prevent Nuclear Proliferation - Vertical	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P-	***Tailored Deterrence***	M	
	The supreme NW power has no constraints and other NW states may seek to better their position or improve their nuclear weapons capability, even if asymmetric.		MAD drove vertical proliferation. Though arms control agreements between the superpowers limited numbers of deployed NW, it did not limit improvement of NW for those states or for other NW states.		This paradigm can enable relaxation and build-down between nuclear peers. Such relaxation and build-down becomes more difficult in multilateral non-peer situations.		
Threshold Deterrence	M	***Capability-Based Deterrence***	M	***Virtual Deterrence***	M	***Unilateral US Transition***	P
Limits build-up relative to deterred state once threshold goal is met. The need to improve NW is limited to ensuring that the threshold continues to be met.		Reductions to a minimum deployed set is the opposite, is an opposite of vertical proliferation.		Reducing to parts is an opposite of vertical proliferation.		By eliminating the NW stockpile, the incentive for peer adversaries to develop more capable and larger NW forces will be reduced, though some temptation main exist to gain dominance. Allies relying on extended US deterrence may elect to improve or expand their NW forces. Regional NW competitors may be largely uninfluenced	

Enhance protection of nuclear weapon-related assets These 3 criteria evaluate the effectiveness a deterrence paradigm to minimize the amounts of nuclear weapon-related material quantities and locations; reduce the overall risk of an accident, theft, compromise, or unauthorized use of nuclear weapon-related assets; and, generally reduce the attractiveness of nuclear weapon-related assets or the opportunity for terrorists to acquire them.

Minimize Nuclear Material Quantity and Locations	***Nuclear Supremacy*** F	***Mutually Assured Destruction*** F	***Tailored Deterrence*** P
	In this paradigm, nuclear weapons are widely deployed in great numbers. Therefore, there are widespread nuclear materials.	MAD arsenals require large amounts of nuclear material and many supporting sites.	Reduced arsenals require less nuclear material and fewer supporting sites. Yet, some material will remain deployed.
Threshold Deterrence P	***Capability-Based Deterrence*** M	***Virtual Deterrence*** M	***Unilateral US Transition*** E
Threshold arsenals are sized to a minimal target set and require less nuclear material and supporting sites. Yet, some material will remain deployed.	The minimum deployed arsenal requires minimum SNM and supporting sites. Nuclear material is centrally located in a few sites to support the potential production need.	Non-deployed NW parts and nuclear material are stored at fewer and more centrally located sites.	No nuclear material is deployed in NW and there are no supporting sites.

Reduces Risk of Accident, Theft, Compromise, or Unauthorized Use	***Nuclear Supremacy*** F	***Mutually Assured Destruction*** F	***Tailored Deterrence*** P+
	The deployment of large numbers of NW entails a corresponding larger risk or accident or diversion.	The deployment of large numbers of NW entails a corresponding larger risk or accident or diversion.	A tailored arsenal lowers the risk of accident or diversion of nuclear material. The distributed nature of the arsenal still presents some inherent risk.
Threshold Deterrence P+	***Capability-Based Deterrence*** M	***Virtual Deterrence*** M+	***Unilateral US Transition*** E
A threshold arsenal lowers the risk of accident or diversion of nuclear material. The distributed nature of the arsenal still presents some inherent risk.	A minimum deployed arsenal substantially reduces risk of diversion or accident. The factory and stored materials are intrinsically less vulnerable than deployed weapons	The lack of a deployed arsenal eliminates risk of diversion or accident of deployed weapons. The stored components are centrally secured and thus less vulnerable.	The elimination of nuclear material and the lack of any deployed NW reduces this risk to zero.

Reduces Attractiveness or Opportunity to Terrorists	*Nuclear Supremacy* P-	*Mutually Assured Destruction* P-	*Tailored Deterrence* P+
	Large deployments of NW could provide many attractive opportunities for terrorists to attempt to acquire nuclear assets. Nevertheless, this paradigm would include ongoing upgrades for surety and use control.	Large deployments of NW would provide many attractive opportunities for terrorists to attempt to acquire nuclear assets. Nevertheless, this paradigm would include ongoing upgrades for surety and use control.	The reduced deployed arsenal and related logistics activities decrease the opportunities for terrorists to acquire NW assets. Nevertheless, some risk will remain.
Threshold Deterrence P+	***Capability-Based Deterrence*** M	***Virtual Deterrence*** M+	***Unilateral US Transition*** E
The reduced deployed arsenal and related logistics activities decrease the opportunities for terrorists to acquire NW assets. Nevertheless, some risk will remain.	This paradigm drastically reduces the opportunity for diversion by minimizing the deployed arsenal and associated logistics chain.	The opportunity relative to a deployed arsenal and its logistics chain is eliminated. The focus is on component storage facilities which are easier to secure than dispersed assets.	Elimination of the nuclear arsenal and associated infrastructure reduces diversion risk to zero.

Provide unambiguous statement of US intent Requires that a paradigm provides clarity about US policy and the circumstances under which various courses of actions would be applied.

Provide Unambiguous Statement of U.S. Intent	*Nuclear Supremacy* E	*Mutually Assured Destruction* M	*Tailored Deterrence* P
	The supremacy of the nuclear weapon force and its potential use is unambiguous.	Force structure is unambiguous. Force has capabilities beyond MAD.	The flexibility inherent in this paradigm results in ambiguity. Nevertheless, nuclear weapon use would not be undertaken lightly.
Threshold Deterrence M	***Capability-Based Deterrence*** P-	***Virtual Deterrence*** P+	***Unilateral US Transition*** P
The threshold force is a credible first strike force, so the conditions of use are unambiguous.	The deployed minimal set provides unambiguous retaliatory (vs. first strike) capability. Nevertheless, the intent of the broader infrastructure capability is inherently difficult to discern.	Reduced readiness posture of adequate force structure is unambiguous. In a crisis, the temptation to escalate from a virtual state to deployment may have ambiguous elements.	Clearly a non-nuclear deterrence posture. But other credible means of accomplishing deterrence are ill-defined and may be lead to greater ambiguity because they may be used for other purposes.

Increase transparency This criteria asks how well a paradigm provides a degree of unambiguous insight into the nuclear activities of all states sufficient to provide enhanced regional and global confidence and security.

	Nuclear Supremacy	P	*Mutually Assured Destruction*	P	*Tailored Deterrence*	E
Increase Transparency	Although, nuclear dominance is transparent, asymmetries are retained to protect advantages and ensure against technical advance by lesser nuclear aspirants.		The parity implied by MAD led both parties to seek enough transparency to make assured destruction credible.		Tailoring requires a thorough understanding of adversaries and threats, which encourages transparency.	
Threshold Deterrence	M	*Capability-Based Deterrence*	P	*Virtual Deterrence*	P-	*Unilateral US Transition*	P
By definition, he deployed force is inherently defensive. Thus, its intent is transparent.		Although the minimal deployed force can be transparent, the activities necessary to maintain the capability are more opaque.		It is difficult for other nations to monitor or have insight into numbers of and status of the parts. In addition, the readiness posture is not easily discerned.		US reliance on non-nuclear deterrence is completely transparent. However, conventional deterrence may be less transparent.	

Reward and incentivize rational state behavior Evaluates how well a deterrence paradigm provides means by which rational states can be convinced that it is to their overall benefit to behave non-provocatively, in accordance with international norms.

	Nuclear Supremacy	F	*Mutually Assured Destruction*	P-	*Tailored Deterrence*	M
Reward and Incentivize Rational State Behavior	A doctrine of supremacy tends to limit the ability of other states to pursue their own interests. Lacking alternatives, other states may behave irrationally.		The risks associated with a conflicts escalating to the point nuclear use are so high that non-existential concerns will tend to receive limited response. Therefore, regional conflicts, proliferation and other such actions might go unimpeded.		This paradigm's response to threats with a proportional (and therefore credible) response motivates states de-escalation and conflict stability.	
Threshold Deterrence	P	*Capability-Based Deterrence*	M	*Virtual Deterrence*	P	*Unilateral US Transition*	P-
This paradigm inherently disincentives nuclear aggression. Nevertheless, it is relatively inflexible, and may induce states to seek advantage or asymmetry.		Because capability based deterrence responds in a timely manner, it enables deliberation and signaling between the parties.		Time delays associated with assembling the force promote stability while the lack of capability to unknown threats may induce other states to gain an asymmetrical advantage.		While this paradigm incentivizes pursuit of asymmetric advantages and nuclear proliferation, it negates US-peer NW arms races.	

Promote and enhance global stability Considers if a paradigm fosters global stability that is robust to both strategic and crisis (such as regional) upsets, by means of a broad framework and mechanisms that reinforce accepted norms.

Promote and Enhance Global Stability	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	M-	***Tailored Deterrence***	M	
	Stability is enforced by nuclear supremacy, though the emphasis on nuclear means may drive other countries to seek capability.		MAD was/is generally stabilizing in a bipolar system. Global stability is achieved at the expense of tolerating or not being able to prevent regional and proxy conflicts. Sub-texts to the MAD theme (damage limitation, war fighting, unacknowledged first strike plans, launch on warning) sowed the seeds of crisis instability.		The broad means to achieve deterrence coupled with the specific targeted response to each threat promotes stability. Undetected development of threats is destabilizing but a globally threatening capability would be difficult to hide.		
Threshold Deterrence	P	***Capability-Based Deterrence***	M	***Virtual Deterrence***	P	***Unilateral US Transition***	F
By definition, this paradigm is stable in a bi-polar context. However, it might not support stability in multi-polar conditions.		Time delay for reconstitution provides a window for crisis management and resolution, and the lack of large deployed forces is inherently stabilizing.		Time delay for reassembly promotes stability in a crisis, but the lack of a minimal deployed arsenal leaves such capabilities vulnerable.		When the US is faced with conventional force, victory may be in doubt but survival is not. Whereas, when faced with a nuclear force survival is in doubt. Thus, for the US conventional deterrence lowers the inhibition on aggression that could increase global conflict.	

Maintain high nuclear threshold The deterrence paradigm ensures high political and technical thresholds regarding the proliferation and malevolent use, respectively, of nuclear technology. The continued respect for the "nuclear taboo" is including in this criteria. In regards to the political threshold, this pertains to a level of shared political will to prevent the spread of nuclear technology to malevolent actors, and to decrease the role of nuclear weapons. The technical threshold pertains to means to: limit the level of technical sophistication available to such actors; as well as, directly limit the use of technology already obtained by such actors.

Maintain High Nuclear Threshold – Political Will	*Nuclear Supremacy* P	*Mutually Assured Destruction* P	*Tailored Deterrence* P+
	Other states are dissuaded from nuclear competition by the high threshold to achieve parity, though the emphasis on nuclear weapons my drive other states to develop indigenous capability.	Assured destruction by second strike capability ensures that weapons are not likely to be used. Nuclear weapons still play a major role.	Although, exquisite understanding of adversary enables non-nuclear means to be employed, in this paradigm there is the potential for a nuclear threat to non-nuclear actions (i.e., a potentially reduced nuclear threshold).
Threshold Deterrence P	*Capability-Based Deterrence* P+	*Virtual Deterrence* P-	*Unilateral US Transition* P-
A state's threshold deterrent relative to a given adversary is also a threat to other states and has deterrent value. This deterrent may be asymmetric to other states, and could tempt nuclear threats to non-nuclear crises.	The minimal deployed set may tempt an adversary to embark on an arms race. However, the robust production capability will tend to dissuade arms races.	The static nature of this paradigm might incentivize a state to acquire a deployed (real) nuclear force and encourage arms races.	Some states follow the US lead respond positively and renounce nuclear aspirations. Nevertheless, for those that do not, it may lower the threshold because of the asymmetric advantage of even a limited nuclear capability.

Maintain High Nuclear Threshold – Technical Means	*Nuclear Supremacy* P	*Mutually Assured Destruction* P	*Tailored Deterrence* P
	Strong investment in nuclear technology ensures competence to detect nuclear activities but this may only force malevolent programs to become more clandestine. Large body of nuclear knowledge and emphasis on nuclear technology may leak out or be difficult to contain.	Arms race that accompanied MAD has side benefit of assuring availability of state-of-the-art technical means but this may only force malevolent programs to become more clandestine.	In this diverse paradigm, nuclear technology gets less attention and resources than it would in other paradigms. Limited technical means with States thought to be non-nuclear.
Threshold Deterrence P	*Capability-Based Deterrence* P	*Virtual Deterrence* F	*Unilateral US Transition* F
The nuclear threshold force itself may not limit malevolent nuclear behavior and may incentivize it. Nuclear expertise enables technical means of detection and monitoring.	Robust capability includes diverse technical means for both reconstitution and detection. Careful control of nuclear material is essential to prevent proliferation. Relative timescales for reconstitution play an important role in stability.	Nuclear technical means may atrophy and provide little insurance against technical advancements.	Abandonment of nuclear technology may or may not change detection and monitoring ability. This paradigm may have no impact on malevolent actors, and may encourage them due to desire to gain nuclear advantage.

Effectively Utilizes National Resources

This subset of criteria specifically look at the expenditure of resources to achieve the objectives of the paradigm. This includes economics and timely availability of assets and capabilities when required. The flexibility of the paradigm to respond to a technical surprise and to ensure sufficient capability and capacity to respond to diverse challenges are also included.

Agility Examines the influence of the paradigm on the ability to adapt and focus on a changing requirement. Specifically, the technical infrastructure to respond to a changing need for design, certification or manufacture of some element required for national security

or defense. In general, the goal is to be more agile than a potential adversary in the development of a possible threat or asymmetric advantage.

Agility	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	M	***Tailored Deterrence***	E	
	Extensive infrastructure would have been required during design, development and deployment of force. After deployment, however, there would be little need to modify or adapt forces; the static nature of the force may induce over-reliance on deployed force and result in neglect of infrastructure.		Extensive infrastructure existed during design, development and deployment of the MAD force. The competitive nature of MAD resulted in many different types of systems and therefore an agile production and design infrastructure.		The diversity of adversaries and the tailored response to each requires a base level of agility. The continual evolution of threats from differing adversaries requires additional agility for an effective application of this paradigm.		
Threshold Deterrence	P	***Capability-Based Deterrence***	E	***Virtual Deterrence***	F	***Unilateral US Transition***	P
Once the threshold is met there is no need for further development and therefore the need for agility would decrease and the full life-cycle would not be exercised resulting in atrophy.		Capability is derived from infrastructure and agility. This concept is predicated upon deployment of an agile infrastructure that has a shorter response time than emergence of potential new threats.		The fixed inventory of parts constrains options to those which it can support; this is the antithesis of agility. Reliance on the parts inventory means that the life-cycle is no longer exercised and this could result in neglect of the infrastructure.		If US nuclear weapons capability had to be reconstituted it would be less agile than other paradigms. Availability of SNM will be key to reconstitution.	

Provides effective response against technological surprise The ability to retool and focus the sum of the defense infrastructure, including DoD assets, the NNSA nuclear complex, and defense contractors against an unexpected threat or action of an adversary.

Provides Effective Response Against Technological Surprise	***Nuclear Supremacy***	P	***Mutually Assured Destruction***	M	***Tailored Deterrence***	M+	
	Science and technology is part of nuclear supremacy and provides some assurance against surprise. Nevertheless, complacency may desensitize a State with nuclear dominance to emergent novel threats enabled by new technology. After the emergence of a new threat the option to employ a nuclear response exists.		The ongoing, competitive nature of MAD motivates development and sustainment of technical base which lessens the chances of technical surprise.		The nature of tailored deterrence requires close attention to adversaries and a benefit of this is a lessening of the likelihood of technical surprise.		
Threshold Deterrence	P-	***Capability-Based Deterrence***	E	***Virtual Deterrence***	P-	***Unilateral US Transition***	P
Threshold capability constrains response options. The non-competitive and focused nature of threshold deterrence may hinder support for technology base. This option is particularly vulnerable to surprises that counter the threat to the threshold.		Reliance on a responsive capability supporting the life-cycle of the deterrent assures awareness of emerging technologies. Further, this awareness is informed by knowledge of an adversary's developments.		Reliance on existing parts inventory limits response options in the face of unanticipated threats driven by technological advances. Some weapon science and technology (S&T) will remain in support of inventory stewardship. Nevertheless, given the lack of new weapon development work, overall S&T capabilities will erode with time.		Given adequate early warning conventional means may be sufficient to provide assured response to technological surprise. If new technology emerges for which NW are the only credible assured response, then this paradigm fails.	

Sustainable The ability to retain the functions of the defense infrastructure across time. This includes maintaining effective design, certification, development, and manufacturing options; retention of the necessary technical personnel, and the potential for obsolescence of critical components of the paradigm. A portion of this evaluation includes maintaining resolve to retain this components, including political support and resources.

Sustainable	***Nuclear Supremacy*** P	***Mutually Assured Destruction*** M	***Tailored Deterrence*** M
	Sustainability depends on a national will to maintain a dominant nuclear force. Maintaining such force requires a sustained and significant commitment of resources. This commitment may be difficult to sustain in times of economic hardship or times of prolonged stability and reduced threats when a "peace dividend" is expected.	MAD encourages arms races which are resilient to internal political change. Competition driven by fear results in broad public support across the political spectrum. This provides sustainability to all elements of the enterprise. This support still requires large expenditure of resources. This commitment may wane, as for example, in the post-Cold War.	Continual evaluation of and response to changes in external factors exercises most of the elements of the capability base. Dramatic changes will require resolve to insure retailoring to the new situation and commensurate commitment of resources.

Threshold Deterrence P	***Capability-Based Deterrence*** M+	***Virtual Deterrence*** F+	***Unilateral US Transition*** F
Once the threshold for deterrence is attained stewardship becomes the primary activity. Only a portion of the capability is sustained, including assessment, surveillance and maintenance of the forces. Other elements of the capability, such as design or production may atrophy. Geopolitical changes will modify value of threshold assets and may reinvigorate other elements of the enterprise.	Response to a potential threat in sufficient time to deter necessitates a spectrum of capabilities across an agile and diverse complex. These capabilities must not be allowed to deteriorate if this paradigm is to remain effective. Thus, sustainability is assured by design of the complex supporting the paradigm.	By definition, this paradigm relies on parts and inventory in an effort to economize and reduce the cost and size of supporting elements of the infrastructure. Therefore, the sustainment of design, production, and supporting infrastructure has been designed out of the paradigm.	Deterrence based on conventional force would not require a supporting nuclear weapons infrastructure, although other element of a nuclear security complex would be retained. Thus, the nuclear weapons specific elements are unsustained.

Provides/restores confidence in the nuclear weapons complex

This criteria evaluates ability to ensure viability, safety, and security of the nuclear-specific elements of infrastructure, including support of design and manufacturing. It specifically recognizing the highly-specialized nature of nuclear work, and the need to exercise portions of this capability to ensure competence.

	Nuclear Supremacy M+	*Mutually Assured Destruction* E-	*Tailored Deterrence* M-
Provides/ Restores Confidence in the Nuclear Weapons Complex	The diverse deployment of nuclear systems exercises a comprehensive capability of the nuclear weapons complex. As the complete cycle of design through production is exercised, this confidence is retained.	The same competitive elements which ensure sustainability also result in a continued confidence in nuclear capabilities. Competition inherent in MAD provides the foundation for a credible NW complex. The imperative to maintain a lead over the adversary powerfully motivates ensuring competence and excellence.	Emphasis on tailoring will result in focus on many different technologies as well as NW. This will diffuse NW effort as witnessed by the decline of US NW complex since end of Cold War. For US, a factor in the decline of the NW complex is its legacy of a highly-capable, reliable and "long-lived" stockpile which did not require the comprehensive suite of capabilities of the Cold-War complex.

Threshold Deterrence P	*Capability-Based Deterrence* E	*Virtual Deterrence* F	*Unilateral US Transition* F+
The specific threshold held at risk will define the resultant character of the nuclear capability. Some thresholds may not require a comprehensive supporting capability. Pressures to "right-size" the complex could arise. Certain scenarios and thresholds may not provide sufficient support to ensure all capabilities of the complex are meaningfully exercised, thus degrading confidence.	An agile and capable complex is fundamental to this paradigm; the need for timely response is greatly facilitated by exercise of the complex, ensuring confidence. A significant component of deterrence for this paradigm is the complex itself. Therefore, confidence in the deterrent derives from confidence in the complex.	As an inventory of parts is the primary component of deterrence, other elements of the complex including design, certification, and production are effectively decommissioned. Only those portions needed to conduct stewardship of the parts inventory are retained. Thus, a lack of sustainment of these aspects of the nuclear complex occurs, with a resultant loss of confidence.	The nuclear weapons portion of the nuclear security complex would be decommissioned and expertise transferred to other areas. The historic data and experience in nuclear weapons remains, but this knowledge degrades with time becoming increasingly difficult to reconstitute. As an advanced industrial nation, a latent ability to reconstitute the capability of a NW complex will exist, but doing so would not be timely.

Sufficient in capacity Examines the capacity of the option to support potential build of forces should requirements necessitate this option. In particular, that it provides sufficient manufacturing capacity for weapons and delivery systems as well as sufficient specialized materials that historically required long lead-times for production.

Sufficient in Capacity	*Nuclear Supremacy* M	*Mutually Assured Destruction* M	*Tailored Deterrence* P
	Capacity established to assure nuclear supremacy would provide sufficient surge potential for most contingencies.	The competitive nature of the MAD arms race required an agile and vibrant nuclear complex with some excess capacity.	Nuclear capacity is tends to be constrained by the inclusion of several elements in the deterrent posture. As such, resources are spread rather thinly over many deterrent elements, with none having much excess capacity.

Threshold Deterrence P	*Capability-Based Deterrence* M	*Virtual Deterrence* F+	*Unilateral US Transition* P
Surge is not required unless the asset held at risk changes. The weapon complex is sized in proportion to the assets held at risk which. Thus, there is very little excess capacity.	By definition, this paradigm has sufficient excess capacity to provided response on relevant timelines.	The only surge capacity is in excess parts. If more than this number were required, production capability would need to be reconstituted, which cannot be done in a timely manner.	This paradigm relies on robust conventional capacity, which by definition, includes excess capacity and could be surged. Nevertheless, if a nuclear response were required, design and production capability would need to be reconstituted, which cannot be done in a timely manner.

Supports nuclear attribution and forensics This criteria recognizes the close connection between expertise in nuclear defense and the expertise needed for nonproliferation objectives. Specifically, does the option provide expertise in nuclear material detection, storage, accountability, and attribution to ensure that the US retains the ability to determine the origin and design of potential nuclear threats which may be deployed by a variety of adversaries.

Supports Nuclear Attribution and Forensics	*Nuclear Supremacy* M+	*Mutually Assured Destruction* M	*Tailored Deterrence* P+
	The investment in nuclear expertise ensures that attribution and forensics capability is available.	Low trust levels may hinder cooperative exchange of nuclear materials information. But nuclear expertise would supports attribution and forensics.	This paradigm includes expertise to support attribution and forensics, but is not as robust as that in more assertive nuclear paradigms.

Threshold Deterrence P+	*Capability-Based Deterrence* M	*Virtual Deterrence* P	*Unilateral US Transition* P
This paradigm includes expertise to support attribution and forensics, but is not as robust as that in more assertive nuclear paradigms.	Science and tools are available and exercised. Nuclear expertise is valued and always under development. The continual exercise of nuclear capability assures a timely attribution and forensics response.	Nuclear expertise for attribution would have to be maintained in and of itself without the benefit of residing within an active nuclear complex.	Attribution and forensics is important to deter nuclear adversaries. The needed expertise would have to be maintained in and of itself without the benefit of a nuclear complex.

Economics Finally, these two criteria looks at the cost of the paradigm, and the relative resources needed to maintain each option. This includes monetary, facilities, personnel, and the relative efficiency, including beneficial and dual-use technologies, and the autonomy of the option with regard to exclusive and difficult to replicate materials and processes. One criteria examines the cost of the deterrent itself, while the other looks at the cost of the supporting complex.

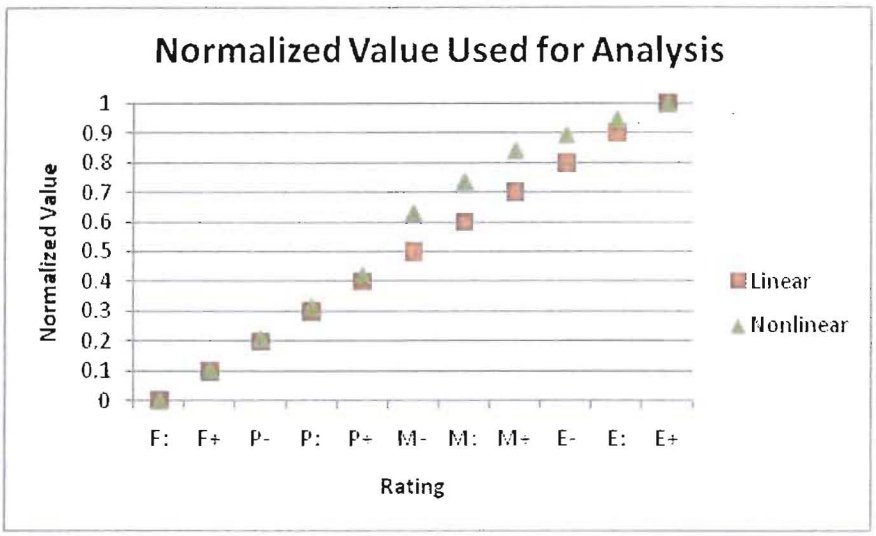
Economics (Cost of Complex)	***Nuclear Supremacy***	P-	***Mutually Assured Destruction***	M	***Tailored Deterrence***	P	
	It is expensive to achieve nuclear supremacy and the marginal cost of maintaining the supporting nuclear complex may also be high. Nevertheless, this paradigm benefits from economy of scale.		Under MAD the cost of other aspects of nuclear force structure, such as delivery vehicles, launchers and command and control dominate the cost of the deterrent. The production complexes for these other aspects are more costly than the nuclear complex. Moreover, in the absence of a nuclear component in deterring conventional threats, the conventional costs would be even higher.		Tailoring to many different adversaries is not necessarily cost effective. Economies of scale are not necessarily realized in each tailored response. Tailoring to some adversaries may involve an emphasis on non-nuclear means which could be even more costly.		
Threshold Deterrence	M+	***Capability-Based Deterrence***	M	***Virtual Deterrence***	E	***Unilateral US Transition***	P-
The nuclear force is not any larger than needed to meet the threshold. Furthermore, an advantage of this option will be lower costs in non-nuclear aspects of deterrence.		Costs are shifted from a deployed nuclear force to the nuclear complex. The minimum deployed nuclear force is less costly than the contingency and hedge forces. Costs are not shifted to conventional forces.		Maintaining an inventory of parts and assembly complex is less costly than maintaining a production complex. The virtual nuclear deterrent replaces the need for certain non-nuclear capabilities and their associated costs.		Although it is costly to sustain adequate and credible conventional forces which have replaced the nuclear deterrent, this option does not incur nuclear-related costs.	

Economics (Cost of Deterrent)	***Nuclear Supremacy***	F	***Mutually Assured Destruction***	P	***Tailored Deterrence***	P	
	The highly capable nuclear deterrent is costly.		MAD deploys a large, costly nuclear arsenal. The arms race aspect of MAD implies a continuing cost. However, the nuclear deterrent offset some conventional costs.		This option uses a spectrum of responses each of which is efficiently sized to a given adversary. However, providing this diversity is costly.		
Threshold Deterrence	M	***Capability-Based Deterrence***	E-	***Virtual Deterrence***	M	***Unilateral US Transition***	F
The deterrent is sized to the threshold and is predominantly nuclear. So, additional expenditures for non-nuclear deterrence are reduced.		Because the deployed forces are minimal, they cost less, and expense is generally realized only if the deterrent must be reconstituted. Absent the exercise of the capability, costs are minimal		Shifting emphasis from deployed forces to parts reduces the costs. Delivery systems will be costly although some dual use platforms may be available.		Deterrence is maintained by conventional means which is very costly.	

Evaluation

While the individual criteria-paradigm assessments allows for analysis of the paradigms across the criteria it is not sufficient for evaluating how well the paradigms compare overall. To make this overall evaluation we use multiobjective value analysis. Multiobjective value analysis is a structured approach that allows comparison of multiple competing objectives when there are no uncertainties about the outcome of the alternatives. For this study, multiobjective value analysis was chosen as framework to provide first order comparative results that could be expanded on using the more general multiobjective decision analysis framework and an explicit modeling of influential uncertainties impacting the future deterrence landscape.

A numerical score of relative value for each of the alphabetic gradations was assessed as shown in the following diagram. Analysis was used with both a linear evaluation of the defined scale and using an assessed valuation that accounts for the significant leap in requirement fulfillment between the Partially-Meets and the Meets Requirements levels. The values, for both scales, were then normalized to allow for comparison of the different results.



Values

	Ordinal (Linear)	Assessed (Nonlinear)
F:	0	0
F+	1	1
P-	2	2
P:	3	3
P+	4	4
M-	5	6
M:	6	7
M+	7	8
E-	8	8.5
E:	9	9
E+	10	9.5

Figure 1: Comparison of values used under an ordinal and assessed system.

The cross-objective valuations was done using swing-weights where the relative importance of each of the subobjectives was evaluated using a U.S. centric and a world-centric basis. Swing-weights are used since they capture both the relative importance of each subobjective as well as the level of tradespace of the alternatives against the subobjective. For example, while the *Assures Security Partners (Extended Deterrence)* subobjective is considered highly important (for both world-centric and U.S.-centric) there is very little variation in the assessments of the alternatives against this subobjective. Thus, while important, it has very little influence on the overall alternative selection and thus has a low swing-weight.

The impact of the tradespace variation on the subobjective's swing-weight is computed using a coefficient computed as the value difference between the best and worst alternative for the

subobjective divided by the total possible value difference. Thus a subobjective where the alternatives span the entire possible range (F to E+) would have a swing-coefficient of one, and those subobjectives where the alternatives have no differentiation would have a swing-coefficient of 0. Allowing $e_{best}(i)$, $e_{worst}(i)$ to be the normalized highest and lowest evaluation of subobjective *i* respectively, then the swing-weight coefficient , $w_{swing}(i)$, can be calculated simply as $w_{swing}(i)=e_{best}(i)-e_{worst}(i)$. Note that an alternative coefficient can be generated by assessing the standard deviation of each subcriteria. For this analysis, results using this method were not substantially different from swing-weight coefficients calculated from the direct differences.

The importance of each subobjective was assessed by measuring the relative placements of the subobjectives using the scale displayed in the following figure. The vertical position (measured in pixels from the center of each subobjective box) was then compared to the relative position of the subobjective assessed to be the best overall (e.g. highest of all subobjective boxes) and the subobjective assessed to be the worst overall. In effect this creates a normalized measure of the assessed importance of each subobjective. If we label the vertical position of the best and worst subobjectives as y_{best} and y_{worst} respectively, then the normalized importance weight, $w_{importance}(i)$ of the subobjective *i* located at y_i would be found as $w_{importance}(i) = \frac{y_i - y_{worst}}{y_{best} - y_{worst}}$. The overall weight, w_i, for any particular subobjective *i* would then be found simply as $w_i = w_{importance}(i) * w_{swing}(i)$.

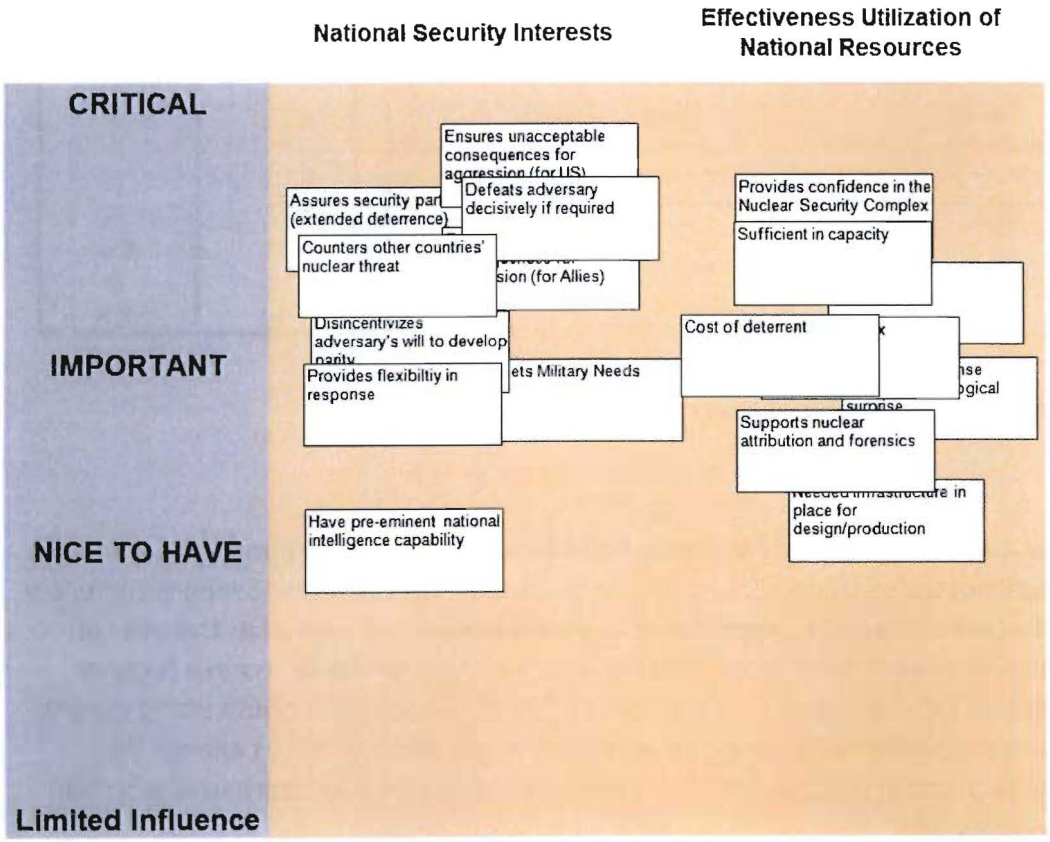


Figure 2: Sample of the format used for evaluating the importance weights of the subobjectives.

Table 1 illustrates the rank order generated by importance only, and swing-weighting of the subobjectives for the U.S.-centric model as well as the swing-weight ordering for the World-centric weighting. As a benefit of using multiobjective value analysis, the addition of any other deterrence paradigm can be made independently of any previous paradigms. By this logic any particular deterrence proposal can be evaluated against those included in this document, and we hope that from this basis better paradigms can be developed.

Assuming criteria *j* (*j =1...* 37 for the 37 total possible criteria) *has* an assessed swing-weight of w_j and deterrence paradigm *x* is has a value against criteria *j* of $val_j(x)$ then the total value for the paradigm, $val(x)$, is calculated as:

$$val(x) = \sum_{j=1}^{37} w_j * val_j(x)$$

Results

The overall evaluation of the different paradigms is shown in Figure 3. The combination of weights and values provides insight both for evaluating the paradigms ability to support overall U.S. deterrence requirements as well as for examining how well each paradigm relates to the seven top level objectives. This evaluation is made by aggregating the weighted sum of the values for all criteria subsidiary to each objective.

As shown by these diagrams the Capability Based Deterrence and Tailored Deterrence paradigms outperform all other alternatives for both the U.S. centric and world-centric assessments. Both of these alternatives are strongly supportive of the objective to lower nuclear risks, which is strongly desired by both the U.S. and the world. They also do well for the objective to Effectively Utilize National Resources and for Enhancing US Standing; the first is weighted strongly in the U.S. perspective, the second for the world. Interestingly, the Nuclear Supremacy alternative proved to be the third best alternative primarily for its strong support of the Protects Vital US Security Interests objective.

From a U.S. perspective the alternative of a Unilateral U.S. Transition to Conventional Deterrence is the least preferred option. This is largely due to the inefficient use of national resources that this paradigm would entail. In the world-centric approach the threshold deterrence paradigm is the worst option due to its weak support for the objectives of Protect Vital U.S. Interests and Enhances U.S. Standing and Reputation.

Table 1: Ordinal ranking of subobjectives based U.S.-Centric vs. World-Centric weightings

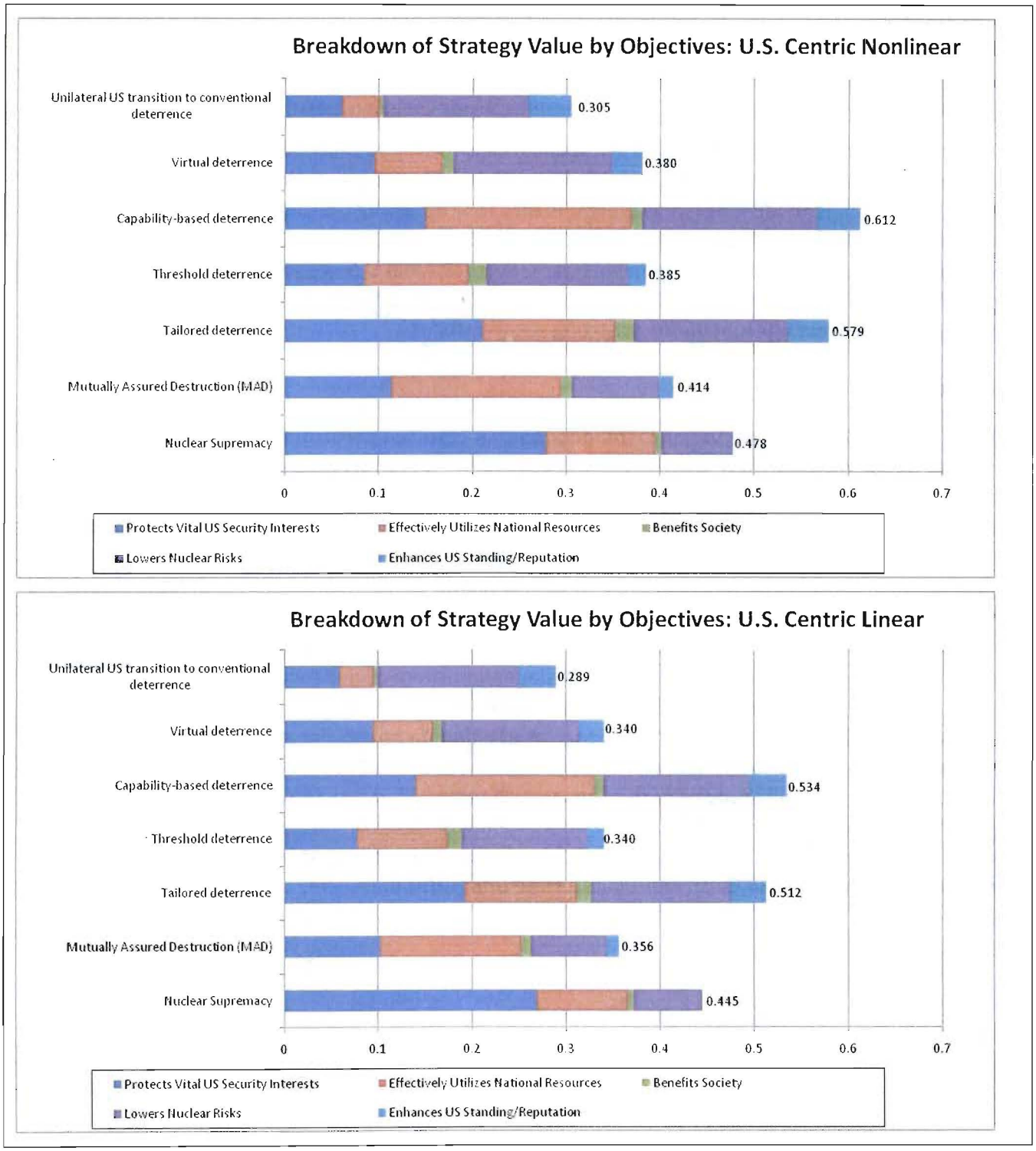
	US Centric (Swing Wieghts)	US Centric (Importance Weights)	World Centric (Swing Weights)
Best	Reduces risk of accident or theft, compromise, unauthorized use	Ensures unacceptable consequences for aggression (for US)	Ensures unacceptable consequences for aggression (for Allies)
	Provides confidence in the Nuclear Security Complex	Reduces risk of accident or theft, compromise, unauthorized use	Meet NPT commitments to Nuclear Disarmament
	Defeats adversary decisively if required	Maintain high nuclear threshold - political will	Counters other countries' nuclear threat
	Ensures unacceptable consequences for aggression (for Allies)	Maintain high nuclear threshold - technical means	Promote and enhance global stability
	Counters other countries' nuclear threat	Provides confidence in the Nuclear Security Complex	Disincentivizes adversary's will to develop parity
	Ensures unacceptable consequences for aggression (for US)	Defeats adversary decisively if required	Reduces risk of accident or theft, compromise, unauthorized use
	Reduces attractiveness or opportunity to terrorists	Reduces attractiveness or opportunity to terrorists	Minimize nuclear material quantity and location
	Provide unambiguous statement of US intent	Assures security partners (extended deterrence)	Be non-provocative to global community
	Sustainable	Provide unambiguous statement of US intent	Creates a "win-win" for US allies and other
	Disincentivizes adversary's will to develop parity	Sufficient in capacity	Increase transparency
	Cost of deterrent	Ensures unacceptable consequences for aggression (for Allies)	Reqard and incentivize rational state behavior
	Sufficient in capacity	Counters other countries' nuclear threat	Positively influence international perception of the US
	Provides flexibiltiy in response	Disincentivize/prevent nuclear proliferation - Horizontal	Support our current diplomatic objectives and commitments
	Promote and enhance global stability	Sustainable	Reduces attractiveness or opportunity to terrorists
	Cost of complex	Promote and enhance global stability	Defeats adversary decisively if required
	Provides response against technological surprise	Disincentivizes adversary's will to develop parity	Supports nuclear attribution and forensics
	Increase transparency	Cost of deterrent	Economic societal /cultural benefits - U.S.
	Minimize nuclear material quantity and location	Cost of complex	Ensures unacceptable consequences for aggression (for US)
	Disincentivize/prevent nuclear proliferation - Vertical	Provides response against technological surprise	Provides response against technological surprise
	Reqard and incentivize rational state behavior	Meets Military Needs	Provide unambiguous statement of US intent
	Meets Military Needs	Increase transparency	Enables beneficial use of nuclear technology
	Disincentivize/prevent nuclear proliferation - Horizontal	Provides flexibiltiy in response	Sustainable
	Meet NPT commitments to Nuclear Disarmament	Disincentivize/prevent nuclear proliferation - Vertical	Support US values
	Economic societal /cultural benefits - U.S.	Reqard and incentivize rational state behavior	Disincentivize/prevent nuclear proliferation - Vertical
	Maintain high nuclear threshold - technical means	Supports nuclear attribution and forensics	Disincentivize/prevent nuclear proliferation - Horizontal
	Needed infrastructure in place for design/production	Economic societal /cultural benefits - U.S.	Maintain high nuclear threshold - technical means
	Supports nuclear attribution and forensics	Minimize nuclear material quantity and location	Provides flexibiltiy in response
	Support our current diplomatic objectives and commitments	Meet NPT commitments to Nuclear Disarmament	Economic societal /cultural benefits - Rest of World
	Creates a "win-win" for US allies and other	Support our current diplomatic objectives and commitments	Have pre-eminent national intelligence capability
	Maintain high nuclear threshold - political will	Needed infrastructure in place for design/production	Provides confidence in the Nuclear Security Complex
	Positively influence international perception of the US	Creates a "win-win" for US allies and other	Needed infrastructure in place for design/production
	Assures security partners (extended deterrence)	Have pre-eminent national intelligence capability	Sufficient in capacity
	Support US values	Positively influence international perception of the US	Meets Military Needs
	Have pre-eminent national intelligence capability	Support US values	Assures security partners (extended deterrence)
	Be non-provocative to global community	Be non-provocative to global community	Maintain high nuclear threshold - political will
	Economic societal /cultural benefits - Rest of World	Economic societal /cultural benefits - Rest of World	Cost of complex
Worst	Enables beneficial use of nuclear technology	Enables beneficial use of nuclear technology	Cost of deterrent

Comparing the linear and the nonlinear valuation of the U.S. centric analysis exacerbates the relative strengths of the more preferred alternatives. While the rank order of the best and worst alternatives does not change, there is some slight differentiation between the alternatives of Threshold Deterrence and Virtual Deterrence using the assessed (nonlinear) values.

Overall, the weights used in the U.S. centric evaluation robustly support the Capability Based Deterrence alternative as the best option as shown in the Objective Sensitivities Charts in the following diagram. The most sensitive weight is that for Effectively Utilizes National Resources that would shift priority to Tailored Deterrence if it were weighted less than 0.2. Perhaps the most interesting crossover would occur if the weight on Protects Vital U.S. National Security Interests were higher than ~56% of the total weight. This large weighting of the priority would place Nuclear Supremacy as the best alternative for its strong security focus.

Discussion

One particularly striking observation is the poor overall assessed performance of "unilateral US transition to conventional deterrence" within this matrix – a matrix containing several national security objectives commonly espoused by its proponents. For example, the paradigm appears to fail to de-incentivize or prevent horizontal nuclear proliferation, and may also fail (depending on the category of states considered) to prevent vertical nuclear proliferation. Regarding horizontal proliferation, a "world of zero" could present an irresistible temptation for states that previously did not choose to compete in the NW arena to achieve the relative advantage afforded by the development of capabilities that could lead to the possession of even a single weapon of relatively modest capability. Without a US nuclear umbrella, one or more of our security partners could feel compelled to enhance their own domestic nuclear capabilities as a "hedge" against a NW breakout by others. Regarding vertical proliferation, the result could be mixed. For states that previously had NW, a zero-weapon norm should significantly constrain (or even continue to prevent) nuclear testing at detectable levels, and the inability to conduct such tests would provide a significant barrier to the further technological advancement of their now-latent NW designs. Vertical proliferation of many latent NW capabilities (e.g. high performance computing, reprocessing, enrichment), however, could continue virtually unabated by any motivated state under this paradigm.


Breakdown of Strategy Value by Objectives: U.S. Centric Nonlinear
Unilateral US transition to conventional deterrence
Virtual deterrence
Capability-based deterrence
Threshold deterrence
Tailored deterrence
Mutually Assured Destruction (MAD)
Nuclear Supremacy
0.305
0.380
0.612
0.385
0.579
0.414
0.478
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Protects Vital US Security Interests
Effectively Utilizes National Resources
Benefits Society
Lowers Nuclear Risks
Enhances US Standing/Reputation
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0.289
0.340
0.534
0.340
0.512
0.356
0.445
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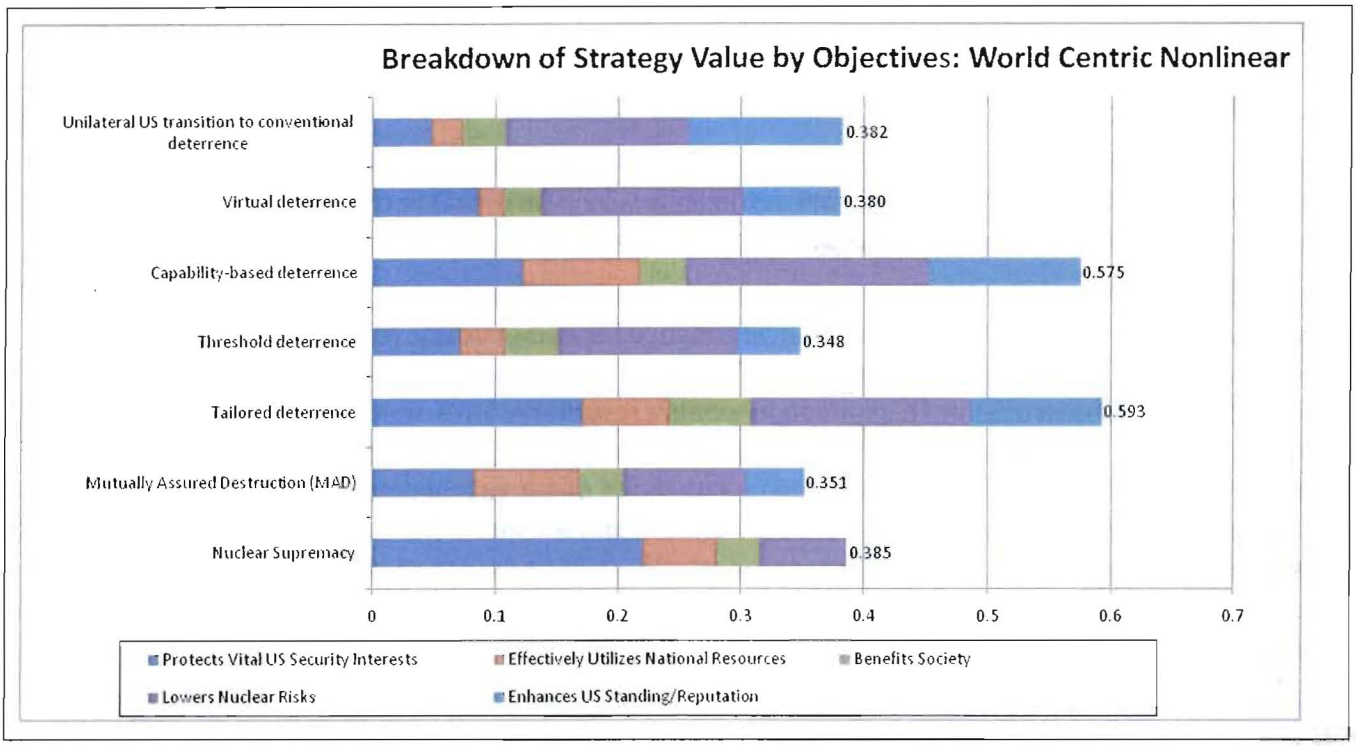

Figure 3: Relative and overall value associated for each paradigm under A) U.S. Centric model using the assessed weights, B) U.S. Centric Model using linear weights, and C) World-Centric Model using assessed weights

An interesting by-product of a "unilateral US transition to conventional deterrence" pertains to the relationship between the pursuit of NW capability and the advantageous by-products it can provide, for example, its useful application to detection and monitoring (including attribution). In what manner can such technologies, necessary to the application and enforcement of the international treaties and agreements that would provide confidence under such a paradigm, be developed and maintained without associated NW programs? Such are difficult challenges that lead most to conclude that such a paradigm is aspirational, and for the far future. Note that our assessment and the relatively poor scoring of the unilateral US transition to zero nuclear weapons is due to the unilateral nature of this objective. Current proponent of "global zero" recognize that all nuclear weapon states must eventually participate in this goal. As stated earlier, this is a substantially different world geopolitical environment than exists today, and hence, this "global zero" vision was not evaluated due to the substantial uncertainties. Our work does show that a unilateral transition has many disadvantages. Pursuit of "global zero" will indeed require a multilateral effort.

Beyond just "deterrence without nuclear weapons", a consideration of global stability attributes across the spectrum of paradigms provides some interesting preliminary insight. First considering "nuclear supremacy" by the US, our small team recognized that whereas global stability might not equate to global happiness, it is difficult to imagine a potential adversary starting a global conflict in such a circumstance. In that sense, an argument can be made that "nuclear supremacy" is inherently stable. Under MAD, on the other hand, global stability is achieved at the expense of tolerating or not

being able to prevent regional and proxy conflicts. Sub-texts to the MAD theme (damage limitation, war fighting, unacknowledged first strike plans, launch on warning, etc.) sowed the seeds of crisis instability.

Under tailored deterrence, a globally threatening capability (while it would be destabilizing) would presumably be difficult to hide. Threshold deterrence would be unstable relative to coalitions, and could fail if the deteree was to calculate a net gain after absorbing the threshold response.

Under capability-based deterrence, the time delay inherent in ramping up the deliverable force would enhance crisis stability by mitigating any chance for early nuclear "over-response". An opportunity to counter strategic upsets would be retained by way of existence of necessary capabilities and infrastructure. This paradigm would presumably have an ability to respond on a relevant, stabilizing timescale (i.e. supporting a feed-back loop which would damp the instability). Some would argue that crisis stability could be enhanced under virtual deterrence, since time would be required to assemble deliverable weapons. Under this paradigm, however, a state would be less able to respond to strategic upsets like technological surprise because of the reliance on "parts over factory." The possible inherent instability of the final paradigm, "deterrence without nuclear weapons", has already been discussed.

Note that three of the seven paradigms (tailored deterrence, threshold deterrence, and capability-based deterrence) avoid a "fail" score, in the team's estimation, relative to any of the "lower nuclear risks" objectives. Whereas this does not prove their de facto superiority versus the other paradigms, it may at least indicate that there could be fewer challenges in managing their associated pros and cons in this area overall.

Summary and Conclusions

We have presented a systems analysis of deterrence paradigms by evaluating a spectrum of 7 possible options against 37 specific criteria grouped into 5 broad categories. We have attempted to be as fair and unbiased as possible in these evaluations, though this exercise is inherently susceptible to bias by its very nature. The results of our work show that those options which attempt to gain the benefits of deterrence while minimizing the cost and number of deployed military assets score best. This is not surprising, as the "have your cake and eat it too" scenarios (Tailored Deterrence and Capability-Based Deterrence) were formulated with just these dual objectives. The ultimate extension of this strategy is a world which gains the benefits of deterrence without the need to deploy nuclear weapons – the "global zero" vision espoused by many including President Obama. While a worthy goal, it is clear that considerable work remains to achieve this vision; today's climate and the criteria important to national security reveal that the conditions for Global Zero do not exist today.

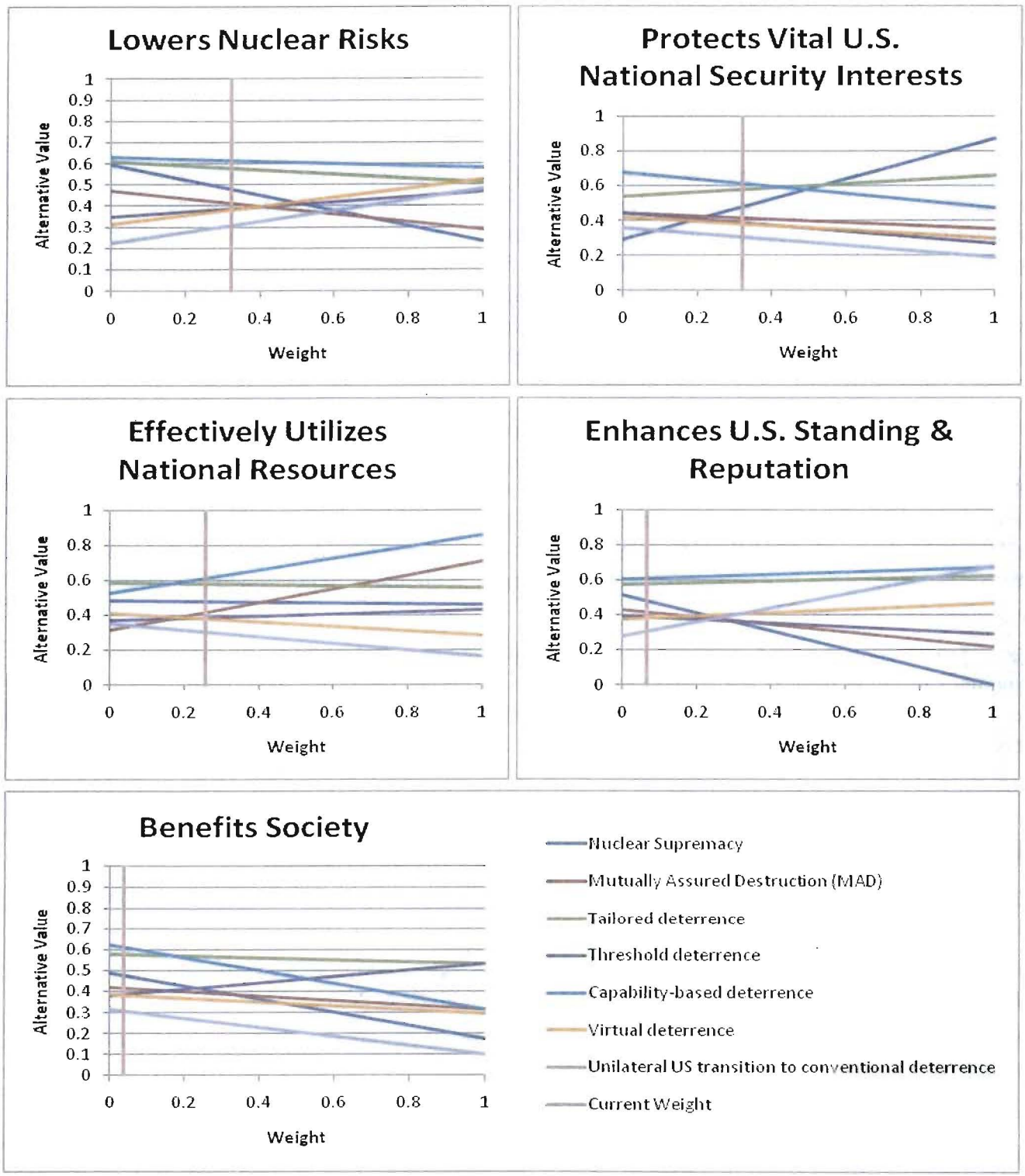

Figure 4: Sensitivity of US Nonlinear evaluation to differing subcriteria weights. The vertical lines represent the current weight for each objective. Paradigms change in assessed overall value as indicated for changes in each objective weight, holding all other objectives relatively equal.

Upon validation and refinement of our methodology it would be illuminating to expand the paradigms and objectives being considered. In our test case, all discussions took place with a lens toward today's global situation. As the US moves forward to craft new deterrence paradigms, new objectives and paradigms representing alternative futures could be examined. An intriguing possibility is "working backwards" from desirable outcomes in the scenario space that we considered and crafting a new, hybrid deterrence paradigm that encompasses strong points of those we considered. The outcome could be a "cross-cutting" deterrence paradigm that is well suited to 21st Century challenges.

While the evaluations within our assessment are open to debate and interpretation, we hope that the overall methodology may hold value in structuring assessments of diverse options. Other, more finally-tuned strategies may be constructed and evaluated. Details such as the specific criteria and alternate paradigms could be readily added to this methodology if desired. If nothing else, approaching the evaluation in this structured manner opened many interesting debates among the authors regarding the role and use of nuclear weapons as elements of policy and influence in international relations.

Specific follow-on to the work presented in this paper might include integrating the assessment and thoughts of other analysts within our framework. Specifically, the use of web-based tools to gather additional comment and grading may be useful. The authors are in discussion with appropriate web-based resources for this purpose.

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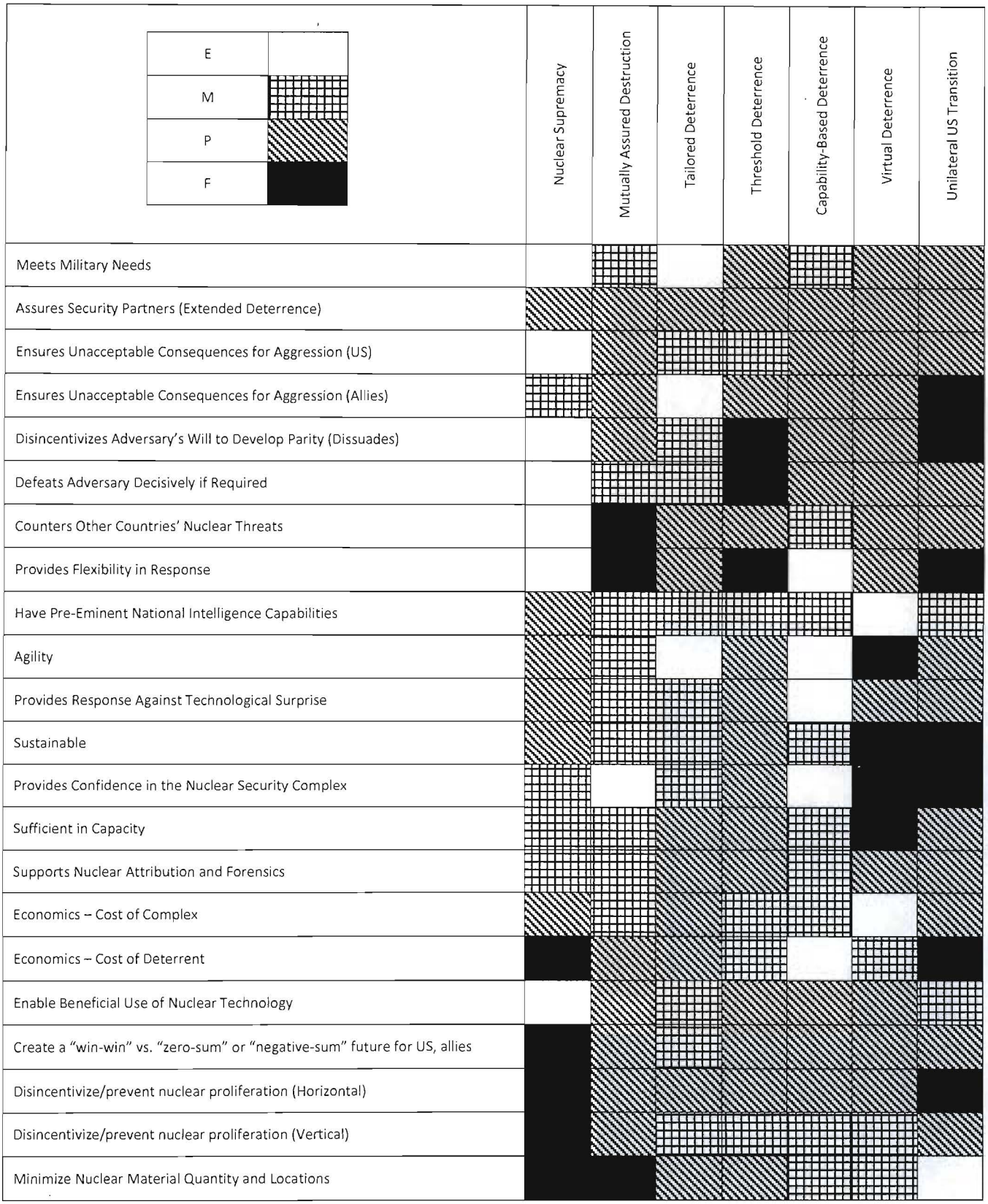
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Nuclear Supremacy
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Economics – Cost of Deterrent
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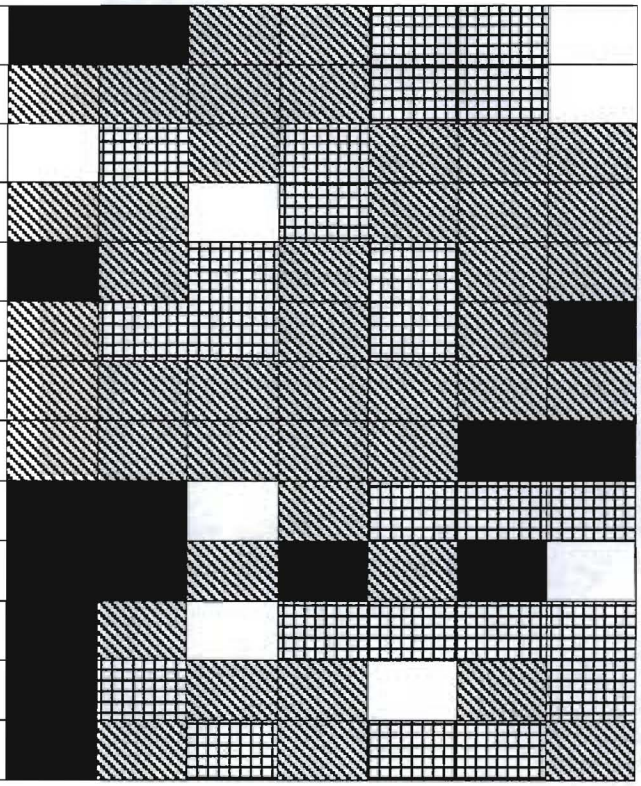
Create a "win-win" vs. "zero-sum" or "negative-sum" future for US, allies
Disincentivize/prevent nuclear proliferation (Horizontal)
Disincentivize/prevent nuclear proliferation (Vertical)
Minimize Nuclear Material Quantity and Locations

Reduces Risk of Accident, Theft, Compromise, or Unauthorized Use	
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