Concepts & Analysis of Nuclear Strategy (CANS – Theory Team)

FRAMEWORK REPORT

CANS INTEGRATION MEETING
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This paper reports the theoretical review and framework development conducted by the STRATCOM/J-5 "Concept and Analysis of Nuclear Strategy (CANS) Theory Team. It reports the theoretical review and framework development with two goals in mind:

1. Framing the problem space surrounding U.S. deterrence, assurance, defeat, counter-proliferation and strategic stability policy objectives in light of varying threats, international environments, and adversary types.

2. Developing an intellectual framework within which the alternative analytic and modeling techniques might be evaluated.

The CANS project is intended to examine the utility of alternative analytic techniques for assessing nuclear force attributes and sufficiency under a variety of changed conditions. This report captures the essence of a continuing discussion rather than a final assessment of the problem space.

This effort is designed to inform debates in this topical area and to facilitate the related CANS modeling efforts that follow. **It is important to note that, as with the entire CANS effort, the theory team was not intended to review or produce policy or force structure recommendations.**

INTRODUCTION

More than twenty years after the common dating of the "end" of the Cold War, US military planners and policy analysts continue to grapple with ways to conceptualize and analyze the sufficiency of our nuclear forces. Specifically, their ability to accomplish major policy goals in a multi-polar world where diverse actors – from "major powers" to those that have been all but disregarded – now constitute significant threats to US and allied interest. Not only is it unclear the extent to which traditional models of nuclear strategy still apply, but efforts to extend them run up against an expanded array of potential threats, types of actors, and foreseeable international environments.

The Concepts & Analysis of Nuclear Strategy (CANS) project undertaken for US Strategic Command (USSTRATCOM) was tasked to examine the utility of alternative analytic techniques for assessing nuclear force attributes and sufficiency under a variety of changed conditions. It was a nine-month effort during which major tasks were divided among three teams:

1. Theory Team: Responsible for reviewing existing nuclear strategy theory, defining terms and establishing an intellectual framework for conducting the study.

2. Analysis Team: Composed of war gamers, strategic gamers, computational and decision modelers, and qualitative researchers who addressed some of the key outstanding questions as they conducted a "deep dive" demonstration of several alternative analytic approaches to the study of nuclear strategy.

3. Integration Team: Tasked with attempting to integrate the outputs generated by the first two teams into a series of conceptual models and a cohesive framework to assist planners and policy analysts as they think through some of the difficult topics they will face in coming years.

The following key questions were addressed by the Theory Team's approach as well as the various deep dive efforts undertaken for the CANS project[1]:

- How do we set up the analytic community to address the next round of arms control relevant to our nuclear forces and strategy?
    - NSI: DAT model
    - NSI: ATOM model
    - Monitor 360: Crowdsourcing
    - DNI: game
- How do the attributes of a potential force posture relate to deterrence, assurance, defeat, strategic stability and counter-proliferation?
    - NSI: ATOM model
    - Carnegie Mellon University Dynamic Network Analysis

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[1] For discussion of the specific modeling efforts undertaken as CANS deep dives see the 5D software tool.

- George Mason University: Pythia
- What are the force structuring questions associated with the anticipated thrusts of upcoming arms control negotiations?
  - DNI game
- How should tradeoffs between force attributes be considered?
  - NSI: ATOM model
- Do changes in US targeting doctrine change our abilities to deter adversaries and assure allies?
  - USAF Game
  - Monitor 360: Crowdsourcing
  - Carnegie Mellon University: Dynamic Network Analysis
  - George Mason University: Pythia
- How should we assess risks and trade-off relationships relative to nuclear force posture and modernization decisions?
  - Monitor 360 Crowdsourcing
  - George Mason University: Pythia

This report outlines the theoretical review and framework development conducted by the CANS Theory Team. The Theory Team Supporting Documents compiles individual pieces written by Theory Team members that focus on specific elements of the framework and their interrelationship. These documents capture the essence of a continuing discussion rather than final judgments, and are best viewed as a "living" product that reflects Theory Team discussions. Both have been refined and amended over the course of the project. The Framework Report and Supporting Documents were designed to inform debate in this topical area, and to enrich and facilitate the Analysis Team's modeling efforts.

The Theory Team was charged with two goals: first, to frame the problem space surrounding the U.S. policy objectives of deterrence, assurance, defeat, strategic stability, and counter-proliferation in light of varying threats, international environments, and adversary types; second, to develop an intellectual framework within which the alternative analytic and modeling techniques might be evaluated.

It is important to note that, as with the entire CANS effort, the theory team was not intended to review or produce policy or force structure recommendations.

This report represents the Theory Team's approach to mapping the scope of the nuclear strategy policy space. However, over the course of this effort it became clear to members of the Theory Team that this mapping process generated further questions, as well as answers. Even now, a number of outstanding issues and theoretical issues challenge our understanding of this problem space. Some of these are enumerated in the "Way Ahead" section at the end of this report.

The Framework Report is organized as follows: A broad view of the problem space associated with assessing nuclear force structure and posture – what the team has called the Problem Space Vortex – is introduced. In essence the Vortex imagines the complex collection of factors that define the space within which force posture and structure trade-

offs and decisions must be made. This is a first step in articulating a credible, useful way of expressing the value of US military capabilities in deterring or defeating adversaries, assuring allies, maintaining strategic stability, and countering potential nuclear proliferation. This is followed by discussion of the 5-Dimensional intellectual framework that was used in this project for organizing and cataloguing alternative analytic approaches according to the types of contexts to which they apply. Each of the five dimensions –policy objective, actor type, threat, world "future", and operation/conflict phase - is discussed individually and multiple models for thinking about the different dimensions are provided. The report concludes with an outline of the overall CANS project. This involved two major activities. The first built on the framework tables that are the culmination of this report (see page 23) to identify pertinent questions and the relevant analytic techniques for addressing them. Simultaneously, the Analysis Team – made up of USAF, USN and DNI war gamers, a George Mason University-led multi-modeling team, NSI decision analysis, and Monitor 360 Crowdsourcing Non-U.S. SME sub-teams -- worked to produce "deep dive" examples, exercising these approaches specifically for the USSTRATCOM problem set.

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At present there exists a dearth of intellectual frameworks and analytic tools for determining force posture requirements relative to non-Cold War assurance and deterrence and linking those policy objectives (and others) to strategy, force and posture. The Theory Team adopted one approach developed by Dr. Christopher Yeaw, Air Force Global Strike Command: the Problem Space Vortex.

Shown below, the Problem Space Vortex is one framework for conceptualizing the complexity of conditions that impact assessment of force sufficiency relative to US policy objectives. The purpose of the Vortex is not to provide a model for implementation, but rather to illustrate the elements that comprise the nuclear strategy space and their position in that conceptual space.
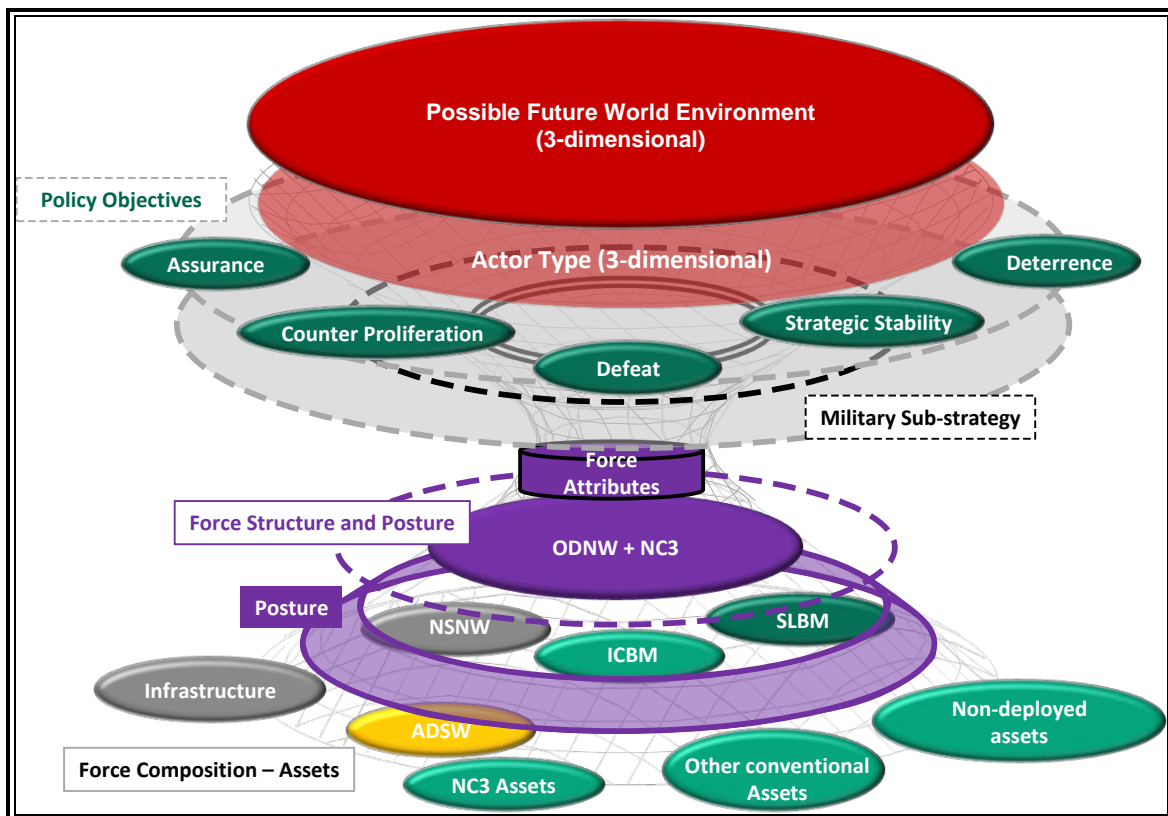

Figure 1: CANS Problem Space Vortex

The top section of the vortex lays out the range of environmental factors relevant to questions that arise regarding the bottom section of the vortex: nuclear and military strategy; force structure and posture, and force composition. When first presented with a

problem or question an analyst could use the Problem Space vortex to help identify the basic elements of the problem space. An analyst could begin by defining and examining the three-dimensional world environment as it relates to nuclear policy and posture. They could then consider that environment in light of the relevant actor types. An analyst could then move on to an examination of US government (USG) policy objectives, including all relevant sub-objectives.

The CANS Problem Space Vortex was designed to capture the broadest possible understanding of the context in which force structure decisions are made. However, for the purposes of analysis and the CANS project tasking, a more contained structure is appropriate. This "Five-Dimensional Framework" is described below.

5-D FRAMEWORK

The CANS theory team was tasked with developing an intellectual framework that identifies how various kinds of models and analytic techniques map to nuclear deterrence and defeat as well as counter-proliferation and assurance-related issues. Following much (and continued) discussion, five critical contextual conditions, or dimensions, with the potential to affect the sufficiency of US forces were identified by the Theory Team. These are: the *policy objectives* the US is seeking to achieve; the type and capabilities of the *actor* it is attempting to influence or defeat; the type of *threat* posed; the nature of the *international environment*, and the operational *phase*. Each of these dimensions, along with some alternative conceptualizations, is discussed in detail below.

The intention of the 5-D framework is to provide a conceptual structure that can be used to organize the environmental problem space visualized by the Vortex. This will not only provide a conceptual guide for the work of the CANS Analysis and Integration Teams, but also serve nuclear force analysts and planners as they work to insure the viability of US deterrence, assurance, counter-proliferation and other policy objectives under varying circumstances.

Dimension 1: Policy Objectives

The starting point for creating a picture of the environment in which force posture decisions are made is to define the US policy objective being pursued. The central decision to be made here is the level of specificity required at this conceptual level. Given the focus of this effort, broad categories are more helpful at this stage. Specifically the theory team focused on five basic policy objectives tied to US nuclear force posture: *deterrence, assurance, defeat, strategic stability and counter proliferation[2].*

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[2] For a more detailed discussion of these policy objectives please refer to the Supporting Documents.

Deterrence

For the purposes of this project we broadly define deterrence as the use of threats by one party to convince another party to refrain from some course of action by exercising decisive influence over their decision calculus. As stated in the DO JOC: "decisive influence is achieved by credibly threatening to deny benefits and/or impose costs, while encouraging restraint by convincing the actor that restraint will result in an acceptable outcome (DO JOC 2006:3)[3]. Most traditional approaches to deterrence[4] – including the DO JOC -- assume the opponent to be rational and self-interested, and thus capable of calculating within their own worldview, whether the cost of a particular action outweighs its expected benefit.

> *Further Thought: In "Extended Nuclear Deterrence: U.S. Alliance Relationships & Implications for Future Nuclear Force Posture," (Supporting Documents) CANS Theory Team member Elbridge Colby discusses critical issues associated with U.S. nuclear extended deterrence commitments, including implications for force structure and posture, as well as assuring allies and convincing adversaries of the reliability of US deterrence commitments.*

Assurance

As originally understood, a policy of assurance rests primarily with US promises to extend its "security umbrella" over allied states (often in the hopes of allaying others' incentives to acquire or increase their own nuclear weapons.) In the nuclear realm this is closely tied to notions of extended deterrence and manifest in defense pacts and other international security arrangements. In a more contemporary sense however, the notion of assurance moves beyond the nuclear security umbrella and promises of kinetic defense to additional means of instilling confidence that the United States possesses the requisite capability and will to address allies' significant security concerns.

> *Further Thought: In "Assurance" (Supporting Documents) CANS Theory Team member Ely Ratner presents a further discussion of the policy of assurance along with an initial conception of principles that may underlie a theory of assurance.*

Defeat

For the purposes of this study, the Theory Team defines defeat as a policy objective in terms of massive or limited punishment goals. The first instance involves operations that destroy civilian and military targets with the intent to inflict maximal damage and may include considerable collateral damage (Helfstein et al., 2008, Kaplan, 1982; Rosenberg, 1983, 1987; Wells, 1981). The second instance refers to limited destruction in two specific scenarios: (a) tactical strikes against adversary military assets with the direct purpose of depriving the

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[3] For a broader discussion see George and Smoke, 1974; Hut, 1999; Danilovic, 2001.

[4] Commonly understood definitions of different forms of deterrence include: deterrence by capability or as in the Deterrence Operations Joint Operating Concept (DO JOC) denial of the benefit of action (e.g., as in the protection from damage afforded by reliable missile defense); deterrence by threat or imposition of cost (DO JOC) including direct deterrent threats, extended deterrence, finite deterrence. For academic discussion of these concepts and others, see Huth (1999); George & Smoke (1974); Huth & Russett (1988); Lebow & Stein (1990); Russett (1963); Stein (1987); Weede (1983); Wu (1990); Zagare & Kilgour (2000); Burr (2009); and Shue (1989).

adversary of those assets, and (b) focused strike against civilian and military targets to dissuade the adversary from escalating conflict (Hagen & Bernstein, 1963; Kaplan, 1982). According to the DO JOC (2006), an effective deterrence policy can augment the pursuit of a defeat objective.

Strategic Stability

In the national security realm strategic stability has typically been referred to as a balance in capabilities and interests between states (e.g., the United States and Soviet Union/Russia) that assured mutual deterrence of nuclear war. More generally, it can be understood as a situation in which war appears unlikely and there is an absence of incentives for preventive war, preemption, an arms race, or a realignment of nations. Stability does not rest on gross numerical balance. For example, with respect to nuclear forces, at present China seems to enjoy a situation of strategic stability with Russia and the United States even though it has far fewer weapons than either state.

Given a multi-polar international system (or, asymmetric multi-polarity) some authors argue that strategic stability is more correctly defined as a circumstance where war between nuclear states is extremely unlikely (East-West Institute, 2010). Moreover, the threats to strategic stability have expanded beyond massive nuclear use to include cyber attack, economic interdependence and attack, and sophisticated non-nuclear conventional systems. Factors believed to impact strategic stability include: ballistic missile defenses and early warning systems, prompt global strike capabilities, counterforce capabilities, and nuclear proliferation.
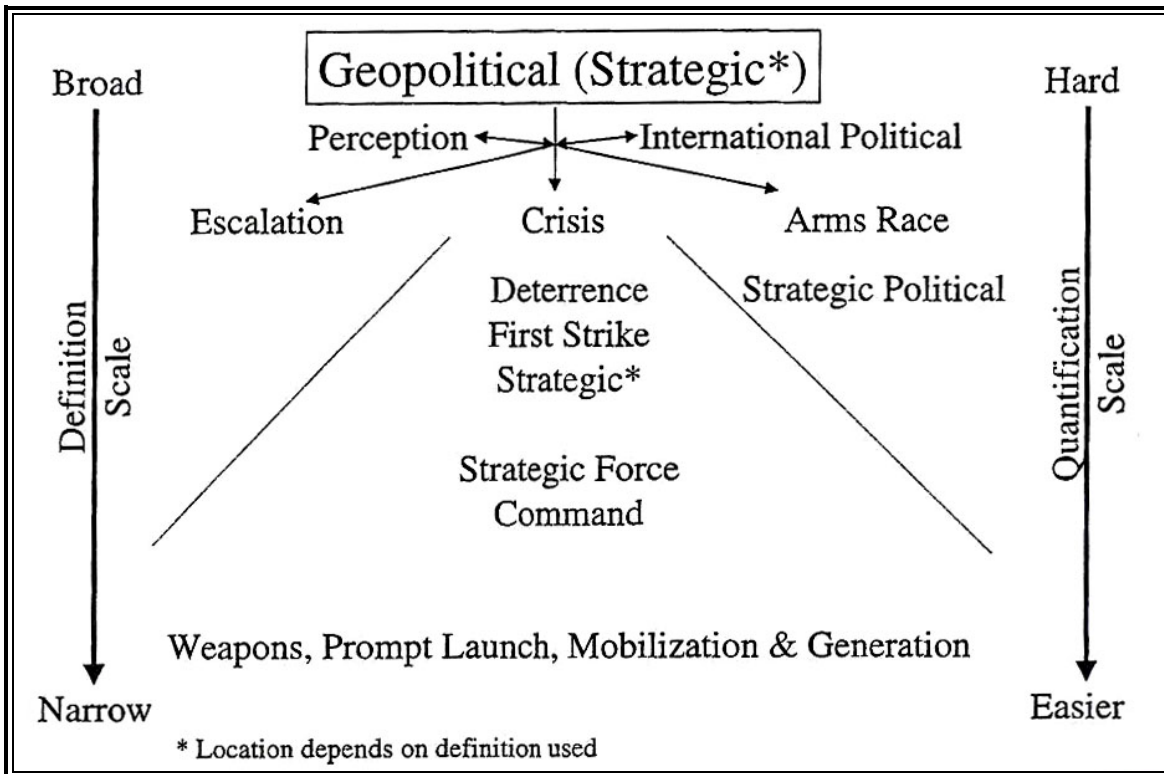
Figure 2: Mc Kenna's Stability Typology

Counter-Proliferation

Counter-proliferation efforts involve actions and initiatives designed to prevent the acquisition of nuclear weapons by states or networks that do not possess such weapons currently (Butcher, 2003) and to protect U.S. interests and allies against conflict between adversaries already armed with weapons of mass destruction. These efforts include: deterrence; sanctions; defensive measures (e.g., anti-ballistic missile defenses); and the capacity for disabling adversaries.

Current U.S. counter-proliferation policy aims to: (a) discourage interests of states, terrorists, or armed groups from acquiring, developing, or mobilizing resources for WMD purposes; (b) prevent or obstruct states, terrorists, or actors from acquiring WMD capabilities as well as efforts by suppliers to provide such capabilities; (c) roll back or eliminate WMD programs of concern; (d) deter weapons use by those possessing nuclear, radiological, and chemical weapons and their means of delivery; and (e) mitigate the consequences of any use of WMD against the United States or allies (The National Counter-Proliferation Center 2010).
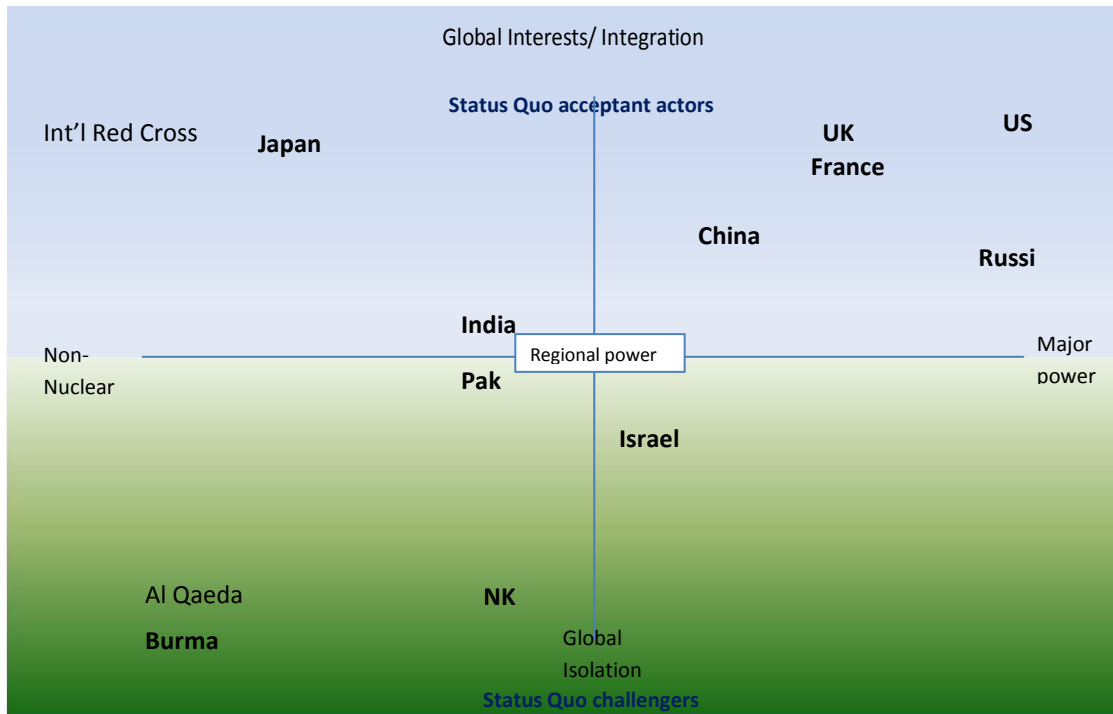
Dimension 2: Actor Type

The effectiveness of a particular policy objective will be conditioned by the type of actor at which the policy is targeted. For example, it is generally understood that because they are easier to target, states are easier to deter than non-state actors. At the conceptual level the

critical task is to identify the characteristics of actors that most directly condition the effectiveness of a policy objective or the force posture that supports that policy objective. As mentioned earlier, one of the challenges facing the U.S. in the post-cold war world is the expanded array of actors in the international arena. There are more states with nuclear capability or nascent nuclear capability, as well as an increasing number of non-state actors that pose a direct threat to the interests and security of the U.S. and its allies. Consequently, the potential threats the U.S. has to consider are not only more numerous, but also more varied. Cold War models and strategies, designed primarily to account for the behavior of the USSR (either directly or indirectly) are unlikely to be effective as frameworks for this more varied set of actors.

The CANS Theory Team developed two ways of thinking about different actor types for this project – one that is best suited for conceptual or theoretical discussions, thought experiments or analyses where continuous actor types are appropriate; and a second that is further specified to make it more "user friendly" for quantitative and computational modelers and those requiring less generalized and more easily measured actor characteristics.   The completed 5-D Framework (discussed below) will include a combination of the two to formulate the discrete actor types needed to produce (a reasonable) five dimensional matrix.

The Theory Team identified three key actor characteristic dimensions critical for considering the range of actors U.S. defense planners and security policy makers should consider in the future: the actor's **military capabilities** relative to others in the global system; the actor's level of **international integration** and the degree to which the actor's interests move beyond parochial to be truly global in nature; and, **territoriality**, or the degree to which the actor represents a territorial entity, or retains assets associated with a relatively bounded physical location.

These are the characteristics considered to be the most relevant to US abilities to deter and assure, and to overall system stability. For the purposes of the 5-D Framework it is most useful to keep each dimension as parsimonious as possible. There are, however, other more specific actor characteristics that become important to consider as we move to the modeling phase.   The three broad conceptual actor characteristics are discussed below. A discussion of the more specific actor variables are presented in the Supporting Documents.

Global Interests/ Integration

Status Quo acceptant actors

Int'l Red Cross   **Japan**   **UK**   US
    France

China

Russi

India

Non-Nuclear   Regional power   Major power

Pak

Israel

Al Qaeda   **NK**

Burma   Global Isolation

Status Quo challengers

Y = International integration   X = Military capability   **Bold** = Actor is territorial

Figure 3: Conceptual Actor Type Space

Military Capability

In all Theory Team discussions as well as recent policy documents (for example the DOJOC and NPR), the issue of an actor's military capability, both nuclear and conventional, was considered to be of paramount importance when considering the impact on other 5-D dimensions, in particular choice of policy objective and the nature of threat posed. It was also recognized that there is a clear difference in the status afforded an actor once it achieves a nuclear weapons capability (Academic literature on deterrence also gives a similar prominence to this capability.). For that reason, the team has disambiguated conventional and nuclear capabilities so that at one end of the military capability continuum are actors with *both* weak conventional and non-nuclear capabilities while the other extreme represents actors possessing both strong conventional and nuclear weapons capabilities. At the mid-point are those actors believed to have developing or nascent nuclear weapons programs and regional power status.

International Integration

One of the strongest findings in the empirical research on the causes of war is the so-called "democratic peace" phenomenon where since the 1800's, although they are equally as war-prone as other regime types, democracies have not fought other democracies (see for example, Chan, 1993; Maoz & Russett, 1993; Ward & Gleditch, 1998). Of course, the democratic nature of a regime also has been closely associated with development of capitalist economies. Furthermore, market-based economies have proven to be successful

and reliable generators of national wealth and power without resorting to territorial expansion. On the contrary, market economies benefit from a peaceful and cooperative international system. Clark (2001) proposes that what we are seeing in the post-Cold War era is the pursuit of security via the proliferation of homogeneity. Morgan (2003) follows this thinking: "Today indicators worth monitoring pertain to the stability and democratic development of great-power political systems, plus their prosperity and openness to flows of technology, trade and investment."

A measure that indicates whether an actor is integrated into the international system captures these empirical results and theoretical understandings. It also taps aspects of some of the actor characteristics that were centrally featured in team discussions including relationship to the United States, actor vulnerability, and decision-making type. As with military capability, the degree to which an actor is integrated with (and by assumption, benefits from) the international community is conceived here as a continuous rather than a dichotomous variable. Thus, at one end of the spectrum are status quo-acceptant actors who are well integrated and whose interests are global in scope. Territorial actors such as the United States and the European Union would fall at this end of the scale, as would non-territorial international actors such as the International Red Cross. At the mid-point are actors with regional level interests and connections; India and Pakistan being good examples. At the other end of the continuum are actors actively challenging the status quo; North Korea (territorial) and Al Qaeda (non-territorial).

Territoriality

Finally, one of the key features of international actors has been the territory they control. In fact, precisely because of their sovereignty over territory, nation-states have a unique place in the international system and were long considered only important actors in international relations (see Morganthau, 1967; Waltz, 1979). Territory provides natural resources that can be translated into economic and political power. Control of territory also implies control of populations that are themselves a resource and source of power. Territory is also the most common cause of conflict between states (Huth, 1996; Senese & Vasquez, 2008). The very factors that make territory valuable also ensure that it becomes a source of conflict.

The lack of territory can, however, also present opportunities, and renders non-state actors less vulnerable to traditional forms of coercive diplomacy. Policies, such as deterrence, are predicated on the threat of force and underlying this threat is the assumption that an actor can be geographically located and targeted. Furthermore, given issues of sovereignty and international law, retaliation against a state for actions taken by those who reside in its territory but are not the recognized government of that territory is potentially fraught. So, even if it is possible to locate a non-state actor, carrying out a traditional threat of retaliation raises considerable issues of credibility above and beyond those traditionally associated with the threat of nuclear retaliation.

Dimension 3: Threat

Policy objectives are designed to counter an existing threat or avoid a future threat to US interests and security. The choice of policy objective and its efficacy is conditioned on the threat it is intended to counter; thus, the nature of the threat influences calculations regarding force posture and must be accounted for.

The 2010 Nuclear Posture Review identifies two classes of threats facing the United States. The first are threats associated with nuclear weapons and materials: attack, proliferation (modernization), terrorism, threats and intimidation, and materials security. The second are global security threats: WMD proliferation, terrorism, and conventional threats from regional actors.

As one way to think about the array of possible nuclear-related threats to U.S. interests, the Theory Team developed a threat-by-conflict stage matrix (shown below) containing three broad types of nuclear-related threats to U.S. security. These are:

Attempts by another actor to attain, develop, expand or buy nuclear weapons or to attain or produce nuclear material;
Nuclear proliferation by another actor or the posturing of existing nuclear weapons by an actor other than the United States; and
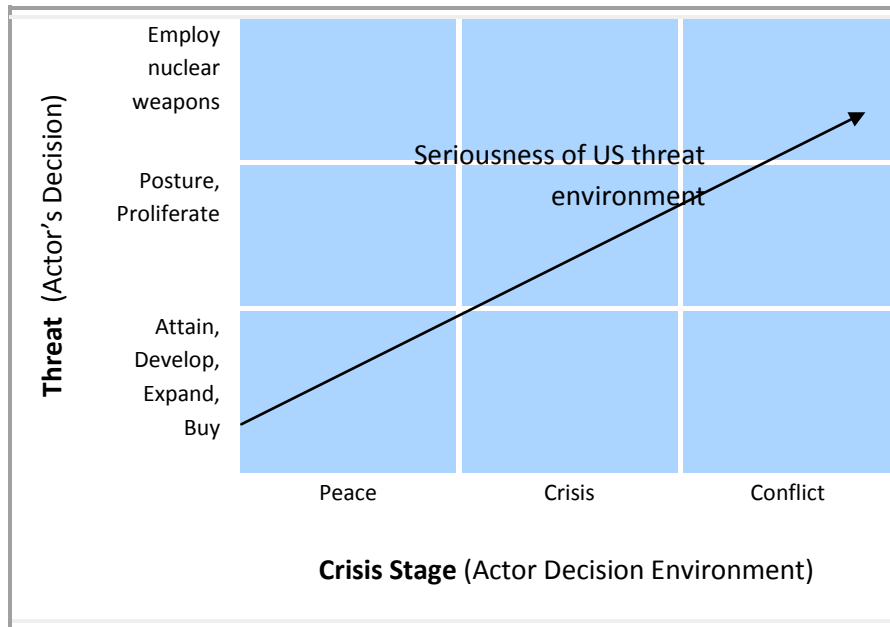The use of nuclear weapons by an actor other than the United States.

Figure 4: US Nuclear Threat Environment

A second, more comprehensive and specific, listing of categories of threat to U.S. interests and security is shown in the figure below. It includes two types of activities that may occur prior to militarized aggression or conflict and one – attack – which can range in intensity

from limited conflict to major war. Given the specific tasking for the CANS effort and the desire to consider a broad range of possible actions and responses this expanded conceptualization of threat is more suited to the purposes of the 5D framework.
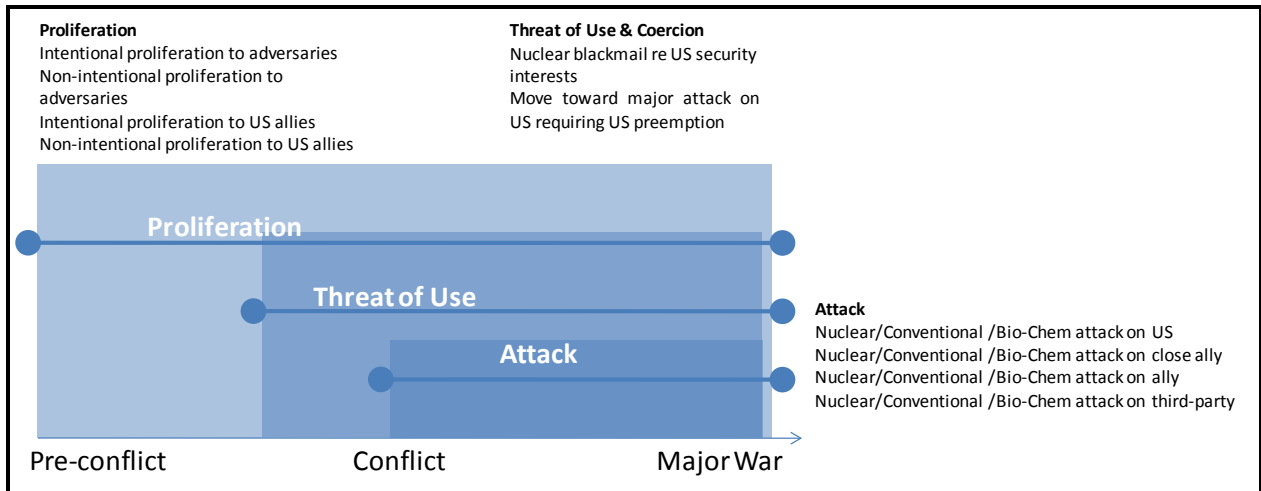
Proliferation
Intentional proliferation to adversaries
Non-intentional proliferation to adversaries
Intentional proliferation to US allies
Non-intentional proliferation to US allies

Threat of Use & Coercion
Nuclear blackmail re US security interests
Move toward major attack on US requiring US preemption

Proliferation

Threat of Use

Attack

Attack
Nuclear/Conventional /Bio-Chem attack on US
Nuclear/Conventional /Bio-Chem attack on close ally
Nuclear/Conventional /Bio-Chem attack on ally
Nuclear/Conventional /Bio-Chem attack on third-party

Pre-conflict   Conflict   Major War

Figure 5: Comprehensive US Threat Environment

Initial threat categories drawn from this broader category are:

Proliferation
     Intentional proliferation of nuclear materials/components to U.S. adversaries
     Non-intentional proliferation of nuclear materials/components to U.S. adversaries
     Intentional proliferation of nuclear materials/components to U.S. allies
     Non-intentional proliferation of nuclear materials/components to U.S. allies

Threat & Coercion
     Nuclear blackmail re U.S. security interests
     Move toward major attack on the United States requiring U.S. preemption

Attack
     Nuclear attack on U.S. territory (first strike against US)
     Conventional attack on U.S. territory
     Biological or chemical attack on U.S. territory
     Nuclear attack on U.S. close ally
     Conventional attack on U.S. close ally
     Biological or chemical attack on U.S. close ally
     Nuclear attack on ally
     Conventional attack on ally
     Biological or chemical attack on ally
     Nuclear attack on third-party
     Conventional attack on third-party
     Biological or chemical attack on third-party

Dimension 4: International Future

Just as actor type can mediate the effectiveness of a particular policy objective, the broader context in which the interaction takes place can influence both the policy choices available to the United States as well as their potential effectiveness. The international future dimension enables us to explicitly account for the impact of system level factors on U.S. security, national interests, and force posture requirements. In the context of the CANS effort, the crucial characteristics to account for are those that are expected to have the greatest influence on the United States' ability to protect and defend its interests, specifically through its nuclear forces.

Conceptualizing the Future

There are numerous ways in which the conceptual framework for the international future dimension can be defined. One of the first choices is whether to structure the framework as a series of discrete futures or as a continuous space. The model originally developed by the Office of the Director of National Intelligence[5] takes the former approach, while the "Alternative Futures" framework[6] developed by CANS Theory Team takes the latter. The second choice relates to the substantive scope of the framework; what dimensions are included? The DNI model aims at a more general picture of the future, whereas the alternative futures model focuses solely on the dimensions considered relevant to nuclear force requirements. By augmenting the DNI futures model to account for the factors most relevant to nuclear force posture decisions we can generate a futures framework that directly maps to the 5D framework.

General Discrete Future: DNI Futures Framework

The DNI futures framework is composed of four discrete futures which represent extremes along two dimensions; nature of the system (competitive/cooperative) and state strength (strong/weak). Conceptually these four combinations create distinct contexts for the security environment that could emerge in 2025 (see Figure 1, Supporting Documents, DNI Futures). The **Concert of Powers** future emerges when there are multiple strong states in a cooperative international system. The **Return of Great Powers** confrontation is a future scenario in which there are also multiple strong states but the international system is competitive rather than cooperative. In a **Fragmented International System** weak states compete in a competitive international environment. In a future characterized by the **Rise of Non-State Networks** there is a cooperative international system, however, states are weak. The expectation of the DNI model is that these ideal types are unlikely to emerge; rather, any future reality will likely incorporate elements of all four.

Focused Continuum Future: Alternative Futures Framework

The CANS Theory Team characterized the "alternative futures" – as they affect U.S. nuclear requirements – in a 3-dimensional space. The three dimensions identified as critical to U.S.

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[5] See Supporting Documents for more detailed discussion of the DNI framework.
[6] See Supporting Documents for more detailed discussion of the Alternate Futures Framework.

nuclear force requirements are the relative strength of U.S. and allied non-nuclear military capabilities, the relationship among great powers, and the extent of proliferation of strategic weapons. Different values across the three dimensions create future scenarios that can be ranked along a continuum from worst to best (see Figure 1, Supporting Documents, Alternate Futures).

Augmenting the DNI Futures Framework for the 5D Context

We start our construction of the comprehensive futures framework by determining the factors crucial to the United States' ability to pursue and protect its interests through both military and non-military means. At the conceptual level these can be thought of as U.S. freedom and capacity to act unilaterally, U.S. ability to influence other actors, and the nature of the international environment. Four assumptions underlie this framework and inform the further derivation of dimensions:

1. International politics will remain competitive and potentially conflictual;
2. The more power (economic, military, political) an actor has, the greater its potential to act in the international system;
3. International norms and regimes can constrain the unilateral actions of actors; and
4. Competing interests and incompatible ideological positions limit cooperative interactions between actors and can become drivers of conflict.

Building on our conceptual factors and assumptions, we identify three system level dimensions as crucial to U.S. force posture decisions.

US Relative Power

U.S. relative power is similar in intent to the Alternative Futures "relative strength of U.S. and allied non-nuclear military capabilities" and "extent of proliferation of strategic weapons" dimensions, however it incorporates economic and soft power (social, diplomatic) factors as well as measures of military power. It is drawn from assumptions one and two.

International Climate

Drawing on assumptions one and four, international climate indicates the level of potential opposition to U.S. goals among both state and non-state actors in the system. While the relative capability dimension measures the extent to which the United States can exert influence over the system through the exercise of power, this dimension indicates the extent to which the United States can expect to find resistance to its policy goals among other actors (both state and non-state). As such, it captures elements of both the DNI (nature of the system) and Alternative Futures (relationship among great powers) frameworks.

Systemic Constraints

This final dimension draws on assumption three to account for the influence of the structure of the international system on the United States' ability to act. Two system characteristics that can influence actors' freedom of action are considered. Building on

assumption two, the first source of influence considered is the extent to which the United States can either exercise, or is subject to, economic pressure due to the level of international economic integration. Building on assumption three, the second source of influence is the effectiveness of international regimes and their similarity to U.S. interests and goals.

Dimension 5: Operational Phase

The final aspect of the strategic environment that directly influences the relevance and effectiveness of a policy and force structure decision is the operational phase against which one is planning or at which one is acting. Certain policy objectives can only be achieved before a situation reaches the point of direct military confrontation.

The operational phase dimension of the 5-D model considers phases as defined in accordance with the six-phase model articulated in Military Joint Publication 3-0 (see below). It is important to recognize that phases are interdependent and the timing of transitions from one phase to the next will be determined by the success of actions taken in a particular phase[7].

Figure 6: Conflict Phase Model (Source: Joint Publication 3-0: 128)
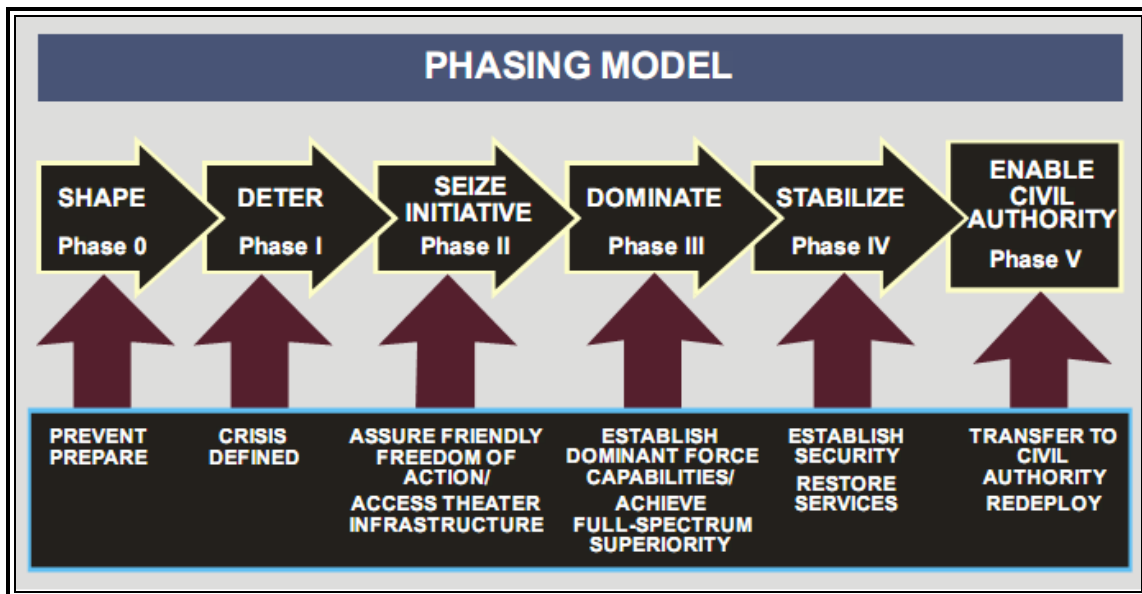
Phase 0: Shape
Phase 0 is the shaping phase during which routine military and interagency actions are performed in support of U.S. objectives. "They are executed continuously with the intent to

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[7] Note the term "deter" used in the phase model is distinct from the notion of "deterrence" as used elsewhere in this effort and by STRATCOM more generally.

enhance international legitimacy and gain multinational cooperation in support of defined military and national strategic objectives" (Joint Publication 3-0: 129).

Phase 1: Deter

Phase 1 occurs once the crisis is defined and actions such as mobilization and pre-deployment of forces are undertaken. The intent during this phase is to deter "undesirable adversary action" (Joint Publication 3-0: 130).

Phase 2: Seize Initiative

Phase 2 is the first phase in which offensive military operations occur. "During this phase, operations to gain access to theater infrastructure and to expand friendly freedom of action continue while the JFC seeks to degrade enemy capabilities with the intent of resolving the crisis at the earliest opportunity" (Joint Publication 3-0: 131).

Phase 3: Dominate

"The "dominate" phase focuses on breaking the enemy's will for organized resistance or, in noncombat situations, control of the operational environment." This involves full employment of military capabilities and can be carried out against both conventional and unconventional opponents (Joint Publication 3-0: 131).

Phase 4: Stabilize

When the United States is engaged in actions in a state where there is limited or no functioning governing entity the stabilization phase is necessary. In this situation U.S. forces may be required to perform governance functions and to coordinate the efforts of other supporting/contributing multinational, OGA, IGO, or NGO participants until legitimate local entities are functioning. "Stability operations are necessary to ensure that the threat (military and/or political) is reduced to a manageable level that can be controlled by the potential civil authority or, in noncombat situations, to ensure that the situation leading to the original crisis does not reoccur or its effects are mitigated (Joint Publication 3-0: 131).

Phase 5: Enable Civil Authority

Once the assessment is made that there is sufficient stability to transfer overall authority to a legitimate civilian entity, Phase 4 ends and Phase 5 can begin. During this phase U.S. forces provide support for the newly installed civil government. The goal is to ensure the viability of the civilian authority and its ability to provide services to the population. "The military end state is achieved during this phase, signaling the end of the joint operation. The joint operation is concluded when redeployment operations are complete" (Joint Publication 3-0: 132).

None of the dimensions of the 5-D model stand alone. Rather, they work interactively to provide a complete and dynamic analysis tool. Change in the value of one parameter can change the impact that other parameter values have. Threat is defined in the framework in terms of actions; however, the extent to which a particular action is threatening is conditioned by who is engaging in that action. For example: Great Britain seeking to modernize their nuclear weapons system is unlikely to be considered a significant threat to U.S. interests or security. However, if North Korea were to engage in the same action it is likely to be perceived to be a greater potential threat.

Thus, the framework provides a nuanced and interactive structure for understanding the complex environment in which force posture decisions are made. By including multiple dimensions, rather than structuring the framework in terms of complete, discrete futures, a high degree of specificity can be achieved within a single parsimonious conceptual structure.
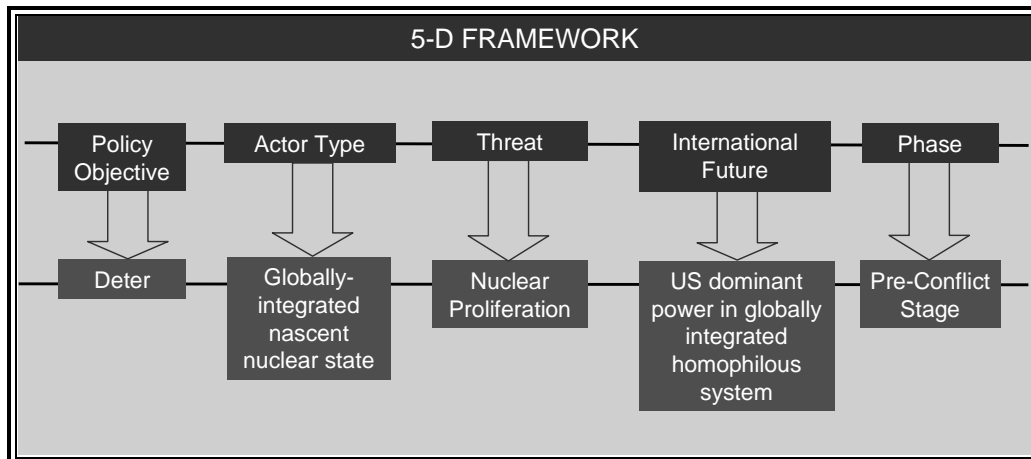
Figure 7: Example of 5-D Structuring of Specific Planning Context

Each 5-D context can be taken to represent a "row" in a framework table. Important information about that context including for example, assessment of available influence levers, appropriate analytic techniques, and data requirements for identifying those levers comprise the columns of the framework. In addition, the framework leads users to consider those contexts and levers in light of varying U.S. policy directives and other political constraints (e.g., a desire to minimize collateral damage, a desire to avoid destabilizing an ally's regime, etc.). Moving through the framework table as an intellectual process finally provides analysts and planners with a schema for considering the sufficiency of

conventional military forces versus the utility of a nuclear force response along with the required attributes and posture of that nuclear force in light of the major components.

One of the primary goals of the CANS Theory Team is to develop an intellectual framework that will help guide deterrence and other planners as well as the work of the analysis and integration teams of the CANS effort. We now can return to the Problem Space Vortex described at the beginning of this report and include the 5-D Framework as the means and process for organizing the contextual layers of that vision.
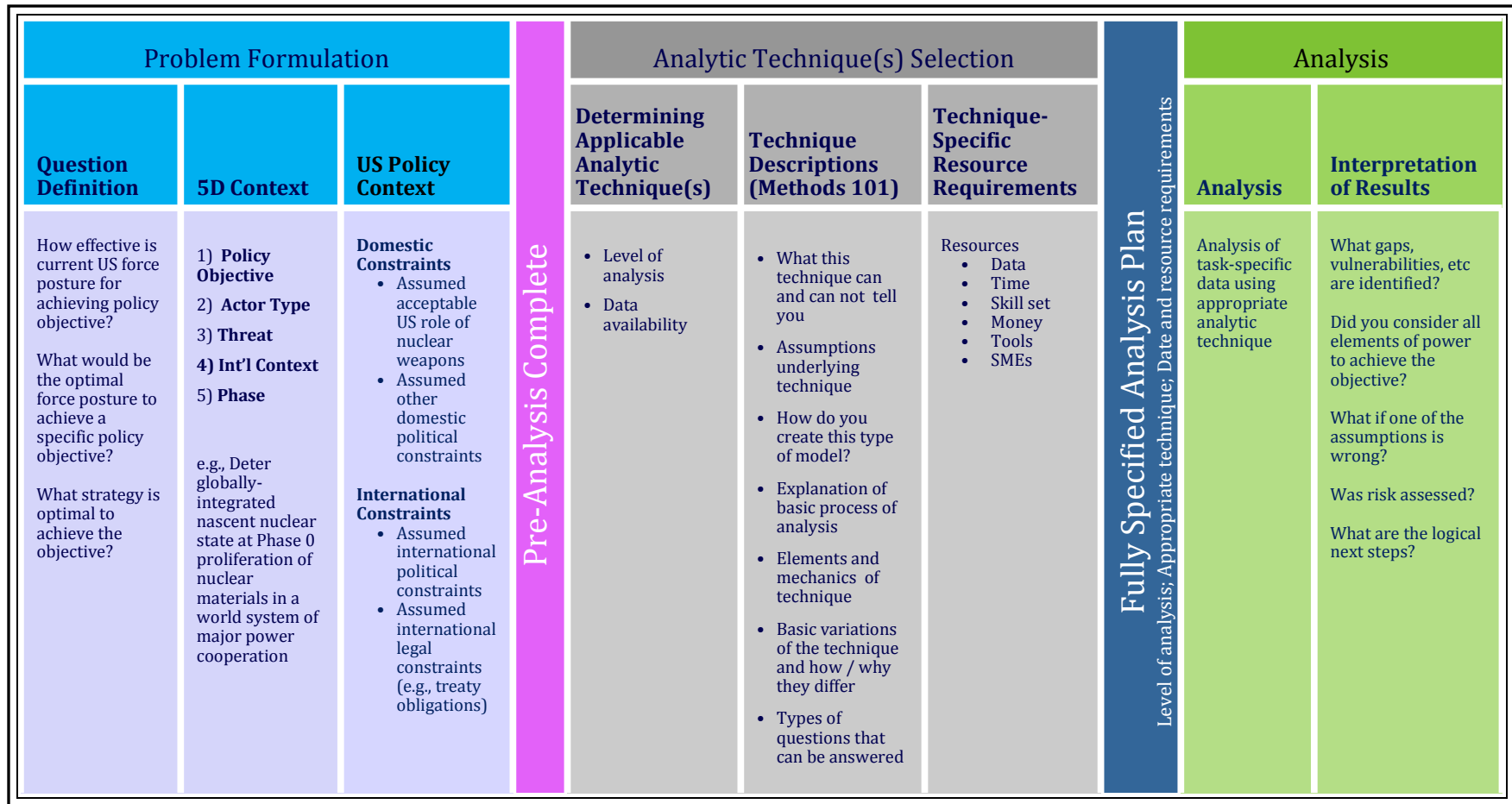
Problem Formulation			Pre-Analysis Complete	Analytic Technique(s) Selection			Fully Specified Analysis Plan Level of analysis; Appropriate technique; Date and resource requirements	Analysis	
Question Definition	**5D Context**	**US Policy Context**		**Determining Applicable Analytic Technique(s)**	**Technique Descriptions (Methods 101)**	**Technique-Specific Resource Requirements**		**Analysis**	**Interpretation of Results**
How effective is current US force posture for achieving policy objective? What would be the optimal force posture to achieve a specific policy objective? What strategy is optimal to achieve the objective?	1) **Policy Objective** 2) **Actor Type** 3) **Threat** 4) **Int'l Context** 5) **Phase** e.g., Deter globally-integrated nascent nuclear state at Phase 0 proliferation of nuclear materials in a world system of major power cooperation	**Domestic Constraints** • Assumed acceptable US role of nuclear weapons • Assumed other domestic political constraints **International Constraints** • Assumed international political constraints • Assumed international legal constraints (e.g., treaty obligations)		• Level of analysis • Data availability	• What this technique can and can not tell you • Assumptions underlying technique • How do you create this type of model? • Explanation of basic process of analysis • Elements and mechanics of technique • Basic variations of the technique and how / why they differ • Types of questions that can be answered	Resources • Data • Time • Skill set • Money • Tools • SMEs		Analysis of task-specific data using appropriate analytic technique	What gaps, vulnerabilities, etc are identified? Did you consider all elements of power to achieve the objective? What if one of the assumptions is wrong? Was risk assessed? What are the logical next steps?

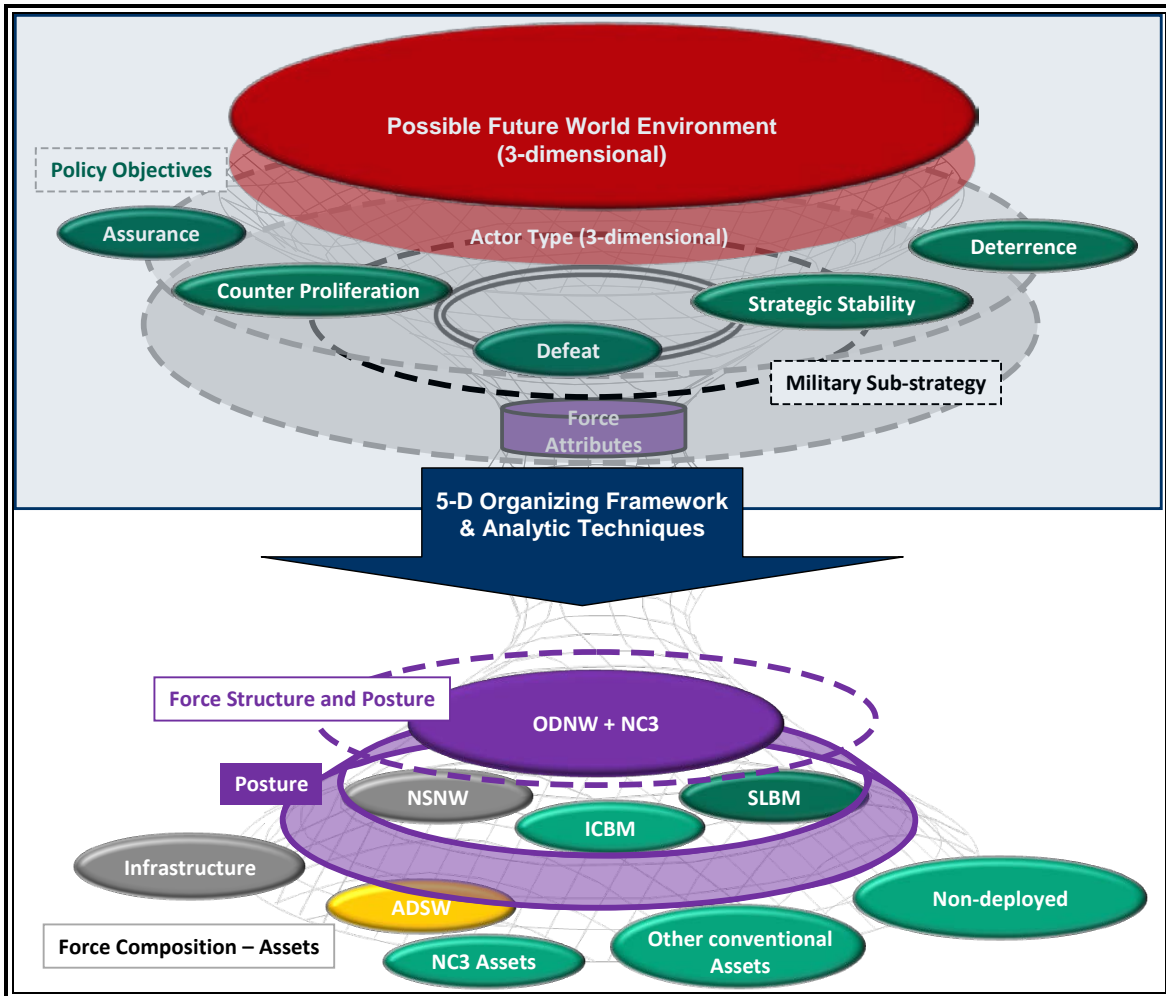**Figure 8: 5-D Framework and Process**

Figure 9: Combining the 5-D Framework and Problem Space Vortex

As shown above, once the five dimensions are defined and their discrete categories are articulated, relevant 5-D contexts can be compiled into a single framework to help users navigate the enormous problem space, feeding assessment of force postures and structure at the bottom of the problem space vortex.

FURTHER THEORETICAL ISSUES

In the process of developing this conceptual framework several broad theoretical issues came to light that were not directly addressed within the discussion of the individual dimensions of the 5D Framework. Individual policy objectives have been explained in some detail, but not their interdependence. The framework itself is structured to provide a global perspective rather than a regional focus. Finally, there is no explicit discussion of time.

Interdependence (between policy objectives)

At this point we have identified five key policy objectives and discussed them independently; however, the relationships *among* policy objectives have not been directly considered. The relationship between deterrence and assurance, which has been touched upon, is complex and deserves deeper consideration. Similarly, the analysis in this paper mentions the potential incompatibility of nuclear deterrence and non-proliferation objectives, but the relationship between the two needs clarification and development.

The deterrence – assurance – counter-proliferation relationship

The interrelationship between the policy objectives identified in the 5D Framework can best be understood by considering a common example; extended deterrence. Extended deterrence involves the United States (Defender) protecting an ally or client state (Protégé), from potential attack from an actor seeking to change the status quo (Challenger). The relationship between the Defender and Challenger is an extended deterrence confrontation, entailing a threat and counter-threat. The relationship between the Defender and Protégé is one of assurance; through the deterrent threat to the Challenger, the Defender is attempting to dissuade the Protégé from taking action on their own, a direct deterrent threat.
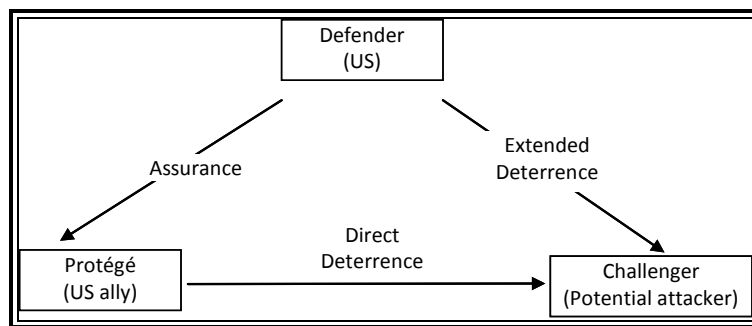

Figure 10: Extended deterrence

An immediate deterrence situation arises when there is a direct challenge by one side (Challenger), countered by the threat of retaliation by the other (Defender) (Huth & Russett, 1988:3). Thus assurance in an immediate deterrence context would involve the United States (Defender) assuring an ally (Protégé) that taking action on their own, in the form of escalation or preemptory military action against the Challenger, was unnecessary.

In a general deterrence situation relations between states are adversarial, but there is no demonstration of overt threat to each other (Huth & Russett, 1988: 3). Thus assurance in an extended general deterrence context would involve the United States (Defender) assuring an ally (Protégé) that action to increase their own military capability (including but not restricted to nuclear weapons) was unnecessary. As such, it contributes to the policy objective of counter-proliferation.

Distance (regional/global)

As presented and discussed, both the Problem Space Vortex and the 5-D framework operate at the global level; however, nothing in either concept precludes their application at the regional level. At this stage, the implications of moving to the regional level of analysis have not been fully developed. In particular, how might U.S. policy in one region inform the behavior and choices of actors – both allies and opponents - in other regions?

It has been suggested that deterrence against smaller actors is qualitatively different from major power deterrence and yet much of our thinking about what makes deterrence successful is rooted in a Cold War world model. Policy scenarios are often framed in terms of the US taking the initiative; however, in a system with fragmented regional issues, it is harder to keep track of potential threats and the likelihood of the United States being confronted with a "fait accompli." That is, we discover a smaller actor has been pursuing an action that poses a threat to the United States (such as procuring nuclear weapons) while U.S. attention has been focused elsewhere. By the time we are aware of the activity it is too late to take steps that would enhance deterrence. Iconic targeting and the behavioral aspects of escalation control are also issues that are connected to the deterrence of smaller actors.

The initial actions that signal an actor's increasing potential to threaten the interests of the United States can be easily missed or misinterpreted. A multipolar world where threats are more diverse and opponents more numerous increases the difficulties associated with the early identification of potential threats. The disaggregated nature of the post-Cold War world also makes it more difficult for the United States to predict and control how its actions in a specific policy context will effect the wider environment. Thus, the level of analysis at which we examine a strategic interaction can influence how we interpret that interaction and out expectations regarding how it will play out. For example, the extended deterrence scenario discussed above, (see Figure 10), can be analyzed as an interrelated set of dyadic relationships (US-Ally; US-Challenger; Ally-Challenger), as a three-actor strategic relationship, as part of a broader regional stabilization endeavor, or, as part of U.S. geostrategic goals. How the analyst chooses to define the problem space will effect the information that contributes to his or her analysis and thus the results of that analysis. During the Cold War, the overarching imperative of containment provided a unifying motivation and rationale for US policymakers. Absent this unifying objective, level of analysis issues have become more salient.

Time

The following discussion is a summary of John Swegle's piece "Deterrence Stability and Escalation Control.[8]"

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[8] Swegle's full piece is included in the Supporting Documents.

Nuclear deterrence, whether in an equilibrium state of *deterrence stability* or in a time-varying state demanding *escalation control*, is in general a dynamic process. Indeed, the larger, collective dynamic of nuclear deterrence, writ large, involves a group of mutually-involved actors – states, non-state terrorist organizations, or even multi-state alliances (e.g., NATO) or groupings (e.g., the United Nations) – and the interplay of the basic elements of nuclear deterrence – to *deter*, *assure*, and *dissuade* (as well as to *defeat* enemies in times of crisis and conflict) – sometimes with multiple elements directed toward a particular state, whether an ally or an adversary.

Defining Deterrence Stability and Escalation Control

As shown in Figure 11 below, the hierarchy of political-military deterrence goals and objectives can be organized by phase (peace; crisis; conflict), the decision time associated with each phase, the higher level of objectives of deterrence stability and escalation control, and their subsidiary goals (deter, assure, dissuade, confront, defend, defeat).
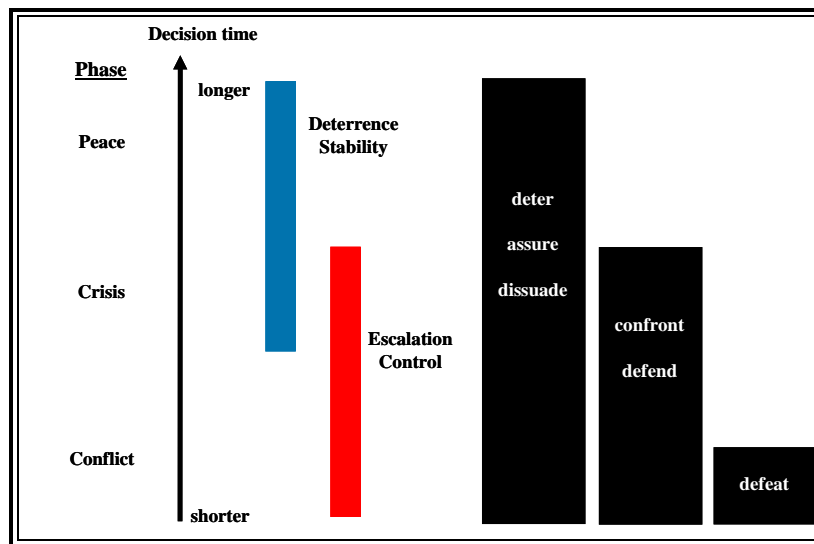

Figure 11: An organization of higher and lower level military and policy goals over the different phases of Deterrence interactions.

As the situation degenerates downward at the left of our figure, the time allowed to make decisions and take actions with the nuclear force shortens. In a time of peace, a stable balance – global or regional – is struck, and the time scale on which decisions are made and actions are taken is sufficiently long that all involved actors – adversaries and allies, competitors and partners – have adequate time to respond. As one descends into crisis, the times for decisions and actions shorten, although until one is sufficiently deep into the crisis phase, the decision and action times could still be long enough to rebalance the situation before new decisions and actions are required in response to changing circumstances. This range of phases, from peace to some level of crisis, and of decision and action times, we refer to as a regime of Deterrence Stability. Even if the situation is changing, the actors have time to rebalance in response.

For further deterioration of the situation, from worsening Crisis toward Conflict, decision and action times continue to shorten to the point that it is no longer possible to rebalance the situation before the other side acts again. In this regime, one cannot achieve stability, so the goal is to control both the rate of escalation of the tension and the level to which tension escalates. This we call Escalation Control.

MOVING FROM THEORY TO ANALYSIS

In his paper *Structuring Analysis to Support Future Decisions About Nuclear Forces and Postures*[9], Paul Davis presents a possible analytic structure for supporting high-level decision making about future nuclear forces and postures. It identifies criteria for assessing options by: reviewing policy debates; reviewing classic criteria but adding candor about how they should be interpreted; and adjusting for modern circumstances in which nuclear weapons play a secondary but still-important role in a challenging new era. The analytic structure highlights diverse types of risk.

The paper illustrates notional use of the structure, which requires identifying an appropriate set of stressful test cases—evaluations for which can be based on, e.g., models and simulations, war games, historical analysis, or structured subjective judgment by analysts or subject-matter experts. The structure deals with major uncertainties and disagreements, rather than attempting to wash away such matters. Finally, the paper identifies questions for research and analysis, and suggests analytic tools that may prove useful in this pursuit. It recommends a new approach to analysis that combines several kinds of modeling with war gaming, expert elicitation, and other sources of information. An unusual feature is making use of synthetic cognitive models to understand possible adversary reasoning in crisis, and to use such models to help structure gaming and simulation.

FULL CANS EFFORT

The remainder of the CANS effort involved two major activities. The first, taken up by the Integration Team, was to further develop the Framework Table with relevant questions and a review and synopsis of relevant analytic techniques for addressing them. These have now been compiled into the 5D software tool. Simultaneously, the Analysis Team – made up of USAF, USN and DNI strategic gamers, a George Mason University-led multi-modeling team, NSI decision analysis, and Monitor 360 crowdsourcing of non-U.S. SMEs sub-teams - worked to produce "deep dive" examples of exercising these approaches specifically for the USSTRATCOM problem set. Write-ups of these efforts have been included as technique-specific examples in the 5D software tool.

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[9] Davis full paper is included in the Theory Team Supporting Documents

USAF and USN War Gamers (Darphaus Mitchell, Curtis Buckle)

The 5-dimensional framework proposed by the Theory Team provides a generic framework for addressing questions of U.S. policy objectives, threat, adversaries, allies, and force structure. However, one of the advantages of testing the framework with the war game and table top exercises conducted by the Air Force A10 and Navy N514B/Naval War College respectively is that they allow exploration of the commonalities as well as the specifics of given regions and the actors that comprise them. In addition, these approaches can help shed light on the relationships between deterrence, assurance, and other policy objectives which have been the subject of much discussion by the theory team.

Specifically, in what has been termed the "Swegle approach,"[10] Theory Team member John Swegle's paper on regional deterrence in Northeast Asia provides an option for designing game-type exercises, and for examining the interaction between global and regional deterrence requirements. Northeast Asia (including: US, China, Russia, North Korea; South Korea, Japan, Taiwan, Australia[11]) is a region which includes many of the variables the theory team saw as relevant to assessment of the sufficiency of U.S. forces. Namely, there are:

- Different actor types: multiple nuclear states, a rogue state with nuclear capability, three major U.S. allies and a sub-national ally (Taiwan);
- History of nuclear threats (North Korea against South Korea and Japan);
- Ongoing territorial disputes (PRC/Taiwan; China/Japan: disputed islands);
- Great power competition; and
- Multiple policy objectives[12] which enables consideration of the potential trade-offs required when attempting to meet contending policy objectives.

DNI Strategic Gamers

In contrast to the service game the DNI strategic game is global in scope. The purpose and concept for the game is to gain insight into global responses to changes in U.S. force posture; focusing on the iterative and complex nature of this relationship. The principle objective of the game is to understand that dynamic as the United States proceeds towards lower numbers of nuclear weapons. Specific path game objectives include:

1. Examination of the implications over time of reducing the number of, and roles for, U.S. nuclear weapons in regard to strategic deterrence, assurance to allies, extended U.S. deterrence, and international stability;
2. Exploration of international reactions to, and impact of, the new U.S. policy; and

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[10] See Supporting Documents for a full discussion of Swegle's approach.
[11] Included at the suggestion of Hunter Hustus.
[12] Swegle identifies four overall U.S. nuclear policy objectives in the region: "1) to deter the use or threat of use of nuclear weapons by China, North Korea, and Russia; 2) to assure Japan and South Korea of the strength of the U.S. commitment to extended nuclear deterrence; 3) to assure Taiwan of the strength of the U.S. commitment that Taiwan should not forcibly be reunified with the mainland; 4) maintain nuclear proliferation stability in the region by preventing the pursuit of nuclear weapons by Japan, South Korea, and Taiwan."

3. Identification of key steps and challenges to a smooth implementation of the new U.S. policy.

George Mason and Carnegie Mellon University Modeling Team

The George Mason University and Carnegie Mellon University team employed its existing system of multiple inter-operating models (multi-modeling) and developed simulation models to support the USAF and USN games. The notional multi-modeling architecture for this problem is shown in the figure that follows. Additionally the teams built on these specific models to generate more generic models.
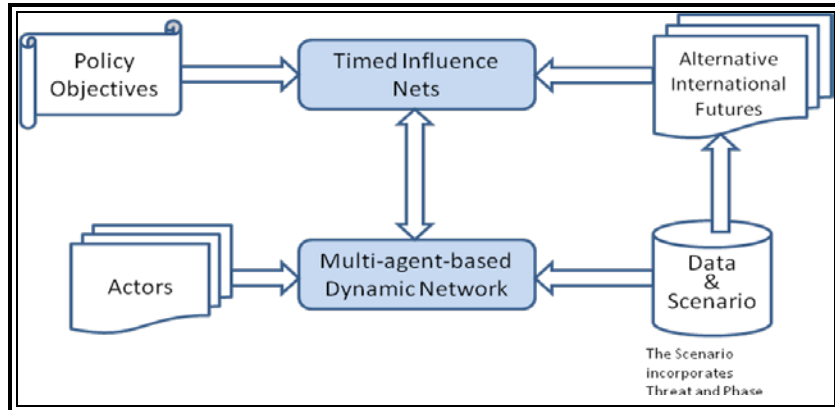

Figure 12: Notional Multi-Modeling Architecture incorporating the 5-D Framework

NSI Decision Analysis

The NSI modeling team develop two models to examine issues related to US strategic decision making as well as the trade-offs associated with different US nuclear force postures. The DAT model applies a non-normative, subjective decision analysis approach to help analysts address such questions as:

- What are the United States' perceived best options or courses of action relative to various policy objectives (deterrence, assurance etc.)?
- How might an actor's decision calculus (i.e., perceived options, interests, priorities) be altered to deter unfavorable actions or encourage favorable ones?
- How robust to decision making types and heuristics are the actor's preferred options (i.e., are there any decision equilibriums)?

The decision analysis process examines a focal actor's perceived options in combination with other actors' possible responses relative to the focal actor's interests. Such analysis can reveal features or patterns in the focal actor's choice sets and suggest ways to alter the choice sets and thereby influence the decision that is likely to be made. The decision analysis process formalizes much of the existing approach used by STRATCOM analysts, combining the advantages of familiarity with added depth and theoretical rigor. As with

other efforts undertaken by the Analysis Team, instances of the decision analysis tool have been developed in the context of East Asia.

The second model from the NSI modeling team, ATOM, formalizes the analysis of trade-offs between force posture attributes relative to dimensions of U.S. policy objectives. The analysis proceeds by first decomposing high-level policy objectives into a hierarchical tree of elemental objectives, constructing a relational mapping of force posture attributes to elemental objectives, and qualifying the strength of those relationships. The model employs a number of approaches for aggregating that information, capturing in detail the trade-offs among elemental objectives that are implied by a given force posture, providing an overall assessment of how well a given force posture is expected to perform relative to the high-level policy objective.

Monitor 360 Crowdsourcing of Non-US SMEs

Monitor 360 focused its crowdsourcing effort on gathering non-U.S. perspectives to improve understanding of foreign attitudes related to U.S. nuclear force posture. This effort focused geographically on East Asia in order to gather regional perspectives about nuclear security, assurance, and stability in the region. The analysis focused on answering critical questions that fall into three broad categories: 1) assurance uncertainties for allies and partners (Japan, South Korea), 2) deterrence uncertainties for adversaries and strategic competitors (China, North Korea), and 3) proliferation uncertainties in states such as Burma. As such it will provide an excellent complement to the services' regional game. Specifically, the Monitor 360 team will engage non-U.S. SMEs to help uncover East Asian attitudes and opinions relevant to questions regarding future U.S. nuclear force posture. This work also helped identify assumptions in East Asia about assurance, deterrence, and stability, which can be incorporated into the USAF A-10 and USN G-5 regional game efforts.

Accuracy

Accuracy is a force attribute that measures the average distance from an intended target a nuclear weapon can achieve. Accuracy is often expressed in terms of Circular Error Probable (CEP), which is a measure of a cruise missile's precision. CEP is the radius of a circle into which a missile will land at least half of the time (Department of Defense, 2010).

Adaptability

Adaptability is a force attribute that measures the ability to change operational or technological features to accommodate new missions and uses (Department of Defense, 2010).

Affordability

Affordability is a force attribute that measures the cost to acquire, maintain, sustain, and operate nuclear forces (Department of Defense, 2010).

Availability

Availability is a force attribute that measures the fraction of nuclear forces that are in a state of readiness for immediate usage (Department of Defense, 2010).

Arms Race Stability

Arms race stability exists when neither side has an incentive to pursue a competitive advantage, nor exchange expenditures for arms (Kruglov &Markov, 1999, 1980). A subset to arms race stability is strategic political stability, which exists when there is no pressure on either side to increase strategic programs (Kruglov & Markov, 1980).

Assurance

As a US policy objective, assurance refers to the promise to extend a "security umbrella" over allied states (DO JOC, 2006; Freedman, 2004; Hopf, 1994; Morgan, 2003; Schelling, 1960).

Basing Flexibility

Basing flexibility is a force attribute that measures the ability to forward base or change basing modes (Department of Defense, 2010).

Breakout

Breakout is the emergence of new nuclear actors. It occurs when a previously Non-Proliferation Treaty abiding non-nuclear actor develops and claims deployable nuclear payloads (Jones and Ganguly, 2003; Niksch, 2003).

Coercion

Coercion is the use of threats or limited force to persuade an opponent to call off or undo an encroachment. Unlike deterrence, which is an effort to dissuade an opponent from taking a

future action, coercion attempts to reverse actions after they have taken place (George and Smoke 1995: 196).

Command Stability
Presence of quality command, control, and communications systems results in command stability (Kruglov & Markov, 1980).

Compellence
Compellence is the use of threats of force or limited force to persuade an opponent to take an action they would not otherwise take (Schelling, 1960).

Compliance
Compliance is the extent to which a state or non-state actor's performance satisfies the regulations and norms applicable via the Nuclear Non-Proliferation Treaty and other non-proliferation and disarmament treaties (Perkovich, Matthews, Cirincione, Gottemoeller, & Wolfsthal, 2007).

Counter-Force
Counter-force strategy is a preemptive attack carried out against an adversary with the intent to destroy their nuclear forces (DO JOC, 2006; Kristensen, Norris, and Oelrich, 2009).

Counter-Proliferation
Counter-proliferation is a policy objective that aims to prevent the acquisition of nuclear weapons by states or networks that do not currently possess such weapons (Butcher, 2003).

Counter-Value
Counter-value strategy involves attacks designed to destroy what an opponent values the most. Common counter-value targets include cities, civilian populations, and industrial infrastructure (Burr, 2005; Corcoran, 2005; Kristensen, Norris, and Oelrich, 2009).

Coverage
Coverage is a force attribute that measures the degree to which a force can hit specified types, categories, and/or numbers of targets (Department of Defense, 2010).

Crisis Stability
Crisis stability is robust when leaders of opposing sides do not feel pressure because of emotion, uncertainty, miscalculation, misconception, or posture of forces to strike first in order to avoid the worse consequence of absorbing a first strike (Kent & Thaler, 1992).

Defeat
As a military objective, defeat reflects a range of destruction and denigration of an adversary's capabilities and resources from massive, involving destruction of civilian and military targets, inflicting maximal damage and including collateral damage to limited, or tactical strikes against adverse military assets with the direct purpose of depriving the

adversary of those assets (Hagan & Bernstein, 1963; Helfstein & al., 2008; Kaplan, 1982; Rosenberg, 1983, 1987; Wells, 1981).

Defense
As a policy, defense refers to actions undertaken to provide protection to the US homeland and overseas bases and territories including information networks and space assets (DO JOC, 2006; Hagan & Bernstein, 1963; Helfstein et al., 2008; Kaplan, 1982; Rosenberg, 1983, 1987; Wells, 1981).

Deterrence
Deterrence is a policy objective that entails the use of threats of military retaliation to convince an opponent to refrain from initiating a given course of action. A threat serves as a deterrent to the extent that it convinces an opponent not to carry out the intended action because of the losses that would be incurred (Huth 1999; 2008).

Deterrence Stability
Deterrence stability exists when there are reduced opportunities and the lack of incentives for either side in a conflict to use its nuclear arsenal for political threats (Kruglov & Markov, 1980).

Disarmament
Disarmament is the process of reducing, restricting, or eliminating the amount and types of offensive weapons an actor possesses (Mingst, 2008).

Dissuasion
Dissuasion is a strategy that seeks to influence the decision calculus of an actor by making one course of action less appealing than another (DO JOC, 2006).

Diversity
Diversity is a force attribute that measures the technological or operational variations within a nuclear force that result in mitigating risks (Department of Defense, 2010).

Endurability
Endurability is a force attribute that measures the degree to which a force is expected to retain operational integrity following a nuclear attack or exchange (Department of Defense, 2010).

Enforcement
Enforcement refers to the specific actions (i.e., sanctions, punishment, constructive engagement) that might be taken in response to a verified instance of non-compliance with a disarmament or non-proliferation agreement (Perkovich, Matthews, Cirincione, Gottemoeller, and Wolfsthal, 2007).

Equivalence
Equivalence is a measure of the extent to which a state's nuclear forces are equal in strength to those of another state (Betts, 1981).

Escalation and Escalation Control

Escalation refers to increasing levels of conflict, which can be visualized as movement along a notional ladder with rungs represented by such actions as show of force, use of force, expanded conventional attack, demonstrative use of nuclear weapons, limited nuclear war, or general nuclear war (Kahn, 1965, 1986; Libicki, 2009).

Horizontal escalation refers to an expansion in physical scope of a conflict, specifically, when a participant in a highly localized war (conventional or in principle, nuclear) initiates a conflict in an additional region (Leites, 1992).

Escalation control is the act, in a conflict, of manipulating the level of escalation. This may be to avoid unintended escalation, to reduce the rate of escalation, or to purposefully escalate a conflict to force the adversary to end the conflict (e.g. the use of nuclear weapons during WWII).

Escalation Stability

Once a conflict has begun, is the trend towards increasing escalation towards total war/ all out nuclear war, or is the trend flat or decreasing (Kruglov & Markov, 1980; Conover, 1977).

First Strike Stability

First strike instability exists when owing to the posture of forces either the leader is perceived to feel pressure to strike first in a crisis to avoid the worse consequences of incurring a first strike. A majority of stability calculations attempt to measure first strike stability (Kruglov & Markov, 1999, 1980).

Geopolitical Stability

Geopolitical stability is a state of relations among nations that is generally consistent with and conducive to change and progress without having to revert to initiating a war with global or regional proportions (Best, 1993). A state of relations is all factors that define a relationship among nations. A stable system is a complex system of interrelated forces in which it is difficult to enumerate all the possible factors and it is even more difficult to determine interrelationships. An example of a factor is military forces (Best, 1993).

Hedging

Nuclear hedging is the creation or maintenance of the perception that an actor possesses the ability to rapidly acquire nuclear weapons. Hedging is based on the technical capacity to produce weapons within a specified amount of time (Brown, 2004).

International Political Stability

International political stability refers to the pre-crisis stability of the international community (Kruglov & Markov, 1980).

Latency

Latency is a situation in which an actor with civilian, but not military nuclear capability, has sufficient capability and expertise to rapidly convert civilian-purposed nuclear energy programs and reactors to militarized nuclear capabilities (Cole, 2009; Roberts, 2009).

Mobilization Stability

Mobilization stability is a condition where both sides in a conflict feel pressure to generate their strategic forces quickly in order to strengthen their deterrent postures (Wilkening, 1983).

Mutual Assured Destruction

Mutual assured destruction is a strategy, based on deterrence, in which use of nuclear weapons by either side would result in the total destruction of both. Thus, any incentive to use nuclear weapons is removed, as is any incentive to disarm (Levine & Levine, 2006; Safranchuk, 2006).

Penetrability

Penetrability is an attribute that measures the ability of a weapon or weapons system to penetrate adversary defenses, including hardened targets, to the degree that it can successfully deliver intended effects. Penetrability is related directly to the probability of destruction, the ability to penetrate land, sea, and air defenses of an adversary in case of actual or threatened nuclear attack (NPR, 2001).

Perception Stability

Perception stability refers to how actors on the world stage perceive relative power, which affects stability (Kruglov & Markov, 1980).

Promptness

Promptness is a force attribute that reflects the speed at which a weapon can be delivered from its normal status to a target (Department of Defense, 2010).

Proportionality

Proportionality is a force attribute that measures the ability to deliver effects commensurate with those eliciting the response. This includes aspects such as yield, special effects, target category, and collateral damage (Department of Defense, 2010).

Range

Range is a force attribute that measures the striking distance of a weapon (Department of Defense, 2010).

Rationality

Rationality is a quality of decision-making that focuses on calculation of cost and benefits. A rational decision is one in which an actor is goal-oriented and selects the option they believe will produce the most favorable outcome at the time they choose (Huth, 2008).

Recallability

Recallability is a force attribute that measures the ability to recall a strike once an operation is underway (Department of Defense, 2010).

Regional Stability
Regional stability is an enduring condition in which states in a specifically defined region, or with interests in a region, have no incentive for armed conventional or nuclear conflict with others in that region (Blair, 1995; Kapur, 2003; Kniksh, 2006; Trompkins, 2003).

Reliability
Reliability as referred to conventional or nuclear forces is an attribute that measures the ability of a weapon or that force to perform missions with confidence under normal conditions (Department of Defense, 2010).

Safety
Safety is a force attribute that measures the probability and consequences of exposure, error, or accident involving nuclear weapons (Department of Defense, 2010).

Secure Second Strike
Secure second strike is the capability of an actor to retaliate with a nuclear attack after having absorbed a counterforce strike. Secure second strike requires nuclear command and control systems and nuclear forces capable of surviving an initial attack. Additionally those nuclear forces must be sufficient to penetrate the opponent's defenses and inflict unacceptable damage (Wilkening, 2008).

Strategic Stability
Strategic stability is an enduring condition in which no state has or perceives an incentive, other than to defend or vindicate the state's most central strategic interests (East-West Institute, 2010).

Strategic Force Stability
Strategic force stability is a state of relations among nations such that none feel an incentive to strike preemptively, in an extreme crisis, due to strategic force correlation or unacceptable damage calculations (Anson & Stein, 1999).

Strike Flexibility
Strike flexibility is a force attribute that measures the capability to adapt the path of a strike to avoid over flight or strike path concerns (Department of Defense, 2010).

Surety
Surety is a force attribute that measures both the security and safety of nuclear forces (Department of Defense, 2010).

Survivability
Survivability is a force attribute that measures the ability to maintain the operational capacity necessary to respond to an attack (Department of Defense, 2010).

Transparency
Transparency is a force attribute that measures the openness of forces or plans to view and inspection by allies or potential adversaries (Department of Defense, 2010).

Upload Capacity

Upload capacity is a force attribute that measures the degree to which upload of additional weapons can be accommodated (Department of Defense, 2010).

Visibility

Visibility is a force attribute that measures the ability to display an alteration in alert posture, escalatory intent, or capability (Department of Defense, 2010).

Verification

Verification is the process of establishing the extent to which a state actor is in compliance with the terms of a disarmament treaty (Perkovich, Matthews, Cirincione, Gottemoeller, & Wolfsthal, 2007).

Weapons Stability

Weapons stability or instability in certain systems such as survivable systems, which inherently tend to be more stable (Kruglov & Markov, 1980).

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