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Process and Results

The Influence of Uncertainty about National Missile Defense Performance on Deterrence During a Crisis

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Introduction

- Introduction
- Cumulative Probability of Escalation
- Key Sources of Uncertainty
- Potential for Misperception
- Conclusions
- Appendix: Participant Biographies



Motivation

Uncertainty pervades WMD issues

- Complexity of factors and relationships that influence human motivations
- Inherent unpredictability of individual and group behavior
- Technical and operational complexity
- Dynamic nature of systems under investigation
- Random phenomena

Uncertainty analysis can make these issues more comprehensible

- The challenge is to develop analyses that address uncertainties in a rigorous manner and present them in understandable and non-misleading ways to decision makers.

"Uncertainty is the only certainty there is, and knowing how to live with insecurity is the only security."

John Allen Paulos, quoting his father in
A Mathematician Plays the Stock Market



Focus: Effects of US NMD on Deterrence

Key questions

- How might uncertainty about, and divergent perceptions about, the effectiveness of U.S. NMD affect deterrence during a crisis?
- How can analysts apply modern approaches to identify, characterize, analyze, and present uncertainties in analyses of WMD issues?

Why *this* focus?

- It is an important question not adequately addressed in the literature.
- It is relatively straightforward to define the problem, yet challenging to analyze.
- It builds on a broad base of prior missile defense analyses and supports ASCO's current deterrence assessment research.

Issues not considered in this effort

- We did not try to resolve the question of how well NMD will work.
- We did not try to resolve the question of whether or not NMD is a good idea.



Approach

Literature survey

- The project started with a survey of the unclassified domestic and foreign academic, FFRDC/national laboratory, and government literature on uncertainty as it relates to analysis of deterrence involving US NMD.

Analytic framework

- We then developed a framework describing the potential influence of beliefs about NMD effectiveness on deterrence.

Scenario

- After considering several potential adversaries and situations, we developed a scenario to provide focus in investigating the influence of uncertainty in missile defense deployment, employment, and effectiveness.

Elicitation of expert opinion

- We designed a structured expert elicitation process to characterize and quantify uncertainties in key parameters of the scenario.
- An elicitation event was held in McLean, Va. on Dec. 2, 2008.

Documentation and analysis of results

- We documented and examined the patterns of expert responses (quant. and qual.).
- We made observations about key issues.



Overview of the Scenario

An extended deterrence scenario

- Two major states (Red, Blue) are in confrontation over a protégé (Green)
- The scenario is structured as an escalating sequence of events (nodes)

The main features of the scenario

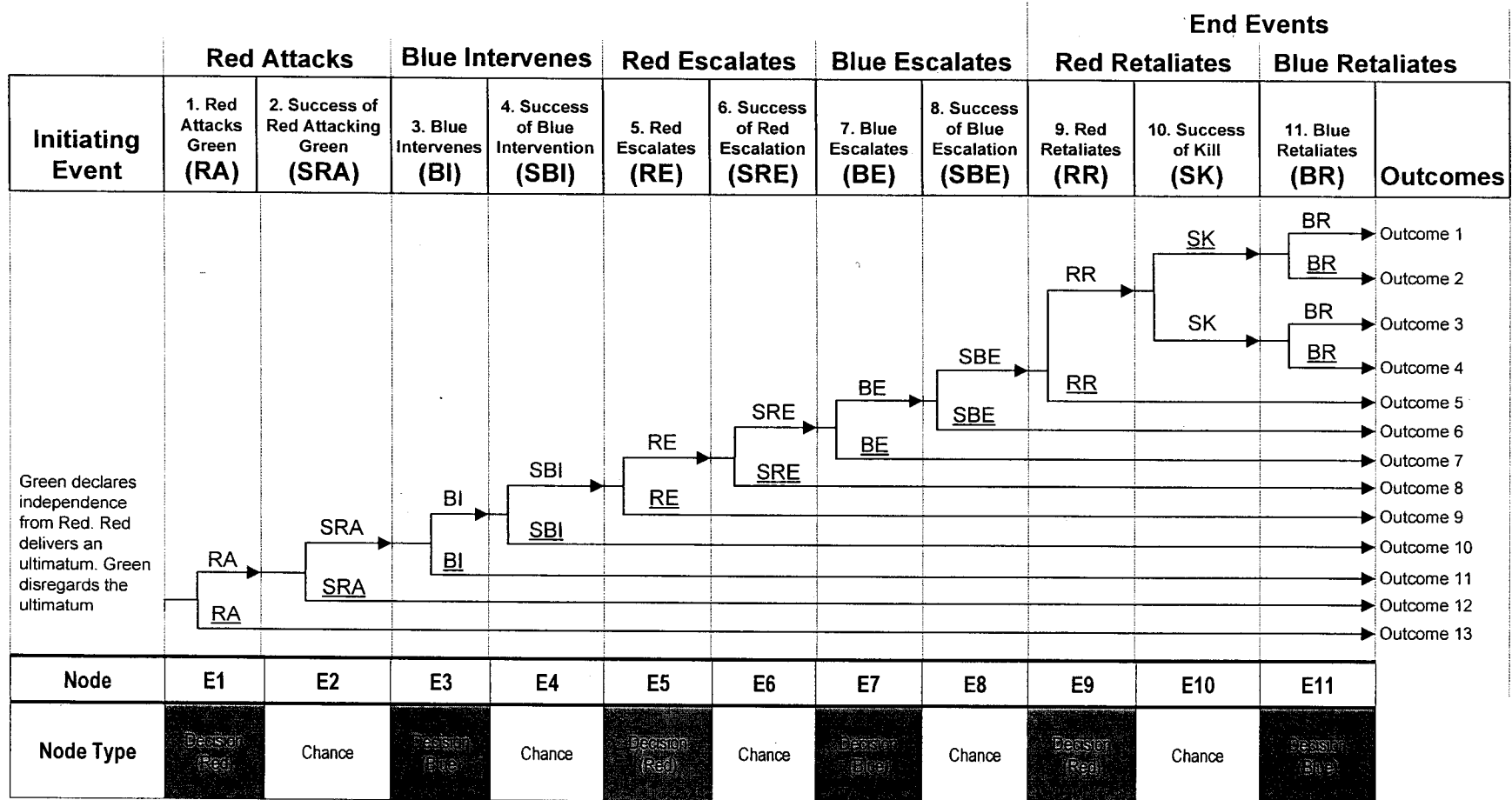
- The scenario progresses from crisis to conventional conflict to nuclear conflict; an NMD intercept attempt occurs late in the scenario
- At different points, either Red or Blue must decide whether to escalate
- An early decision not to escalate can be understood as successful deterrence

Variations on the scenario

- The scenario was re-run with alternative assumptions about the anticipated effectiveness of NMD
 - These alternative assumptions involve an arbitrary certainty about NMD effectiveness (0% or 100%)
- We also inquired into threshold levels of effectiveness
 - The levels of NMD effectiveness that (in your judgment) would influence decisions early in the scenario



The Scenario at a Glance





How The Experts Were Selected

Desired characteristics were identified

- A pool of 6 -12 people with strong relevant expertise
- Diversity of viewpoints
- Availability and willingness to acts as proponents or impartial evaluators
- Strong communication skills and interpersonal skills

Categories of expertise were identified as relevant to the scenario

- Political-military affairs in the region featured in the scenario ("Red")
- U.S. national security decision-making ("Blue")
- Military strategy and deterrence ("Deterrence")
- Physics, engineering, and/or mathematics ("Science")

Criteria were established for extending invitations

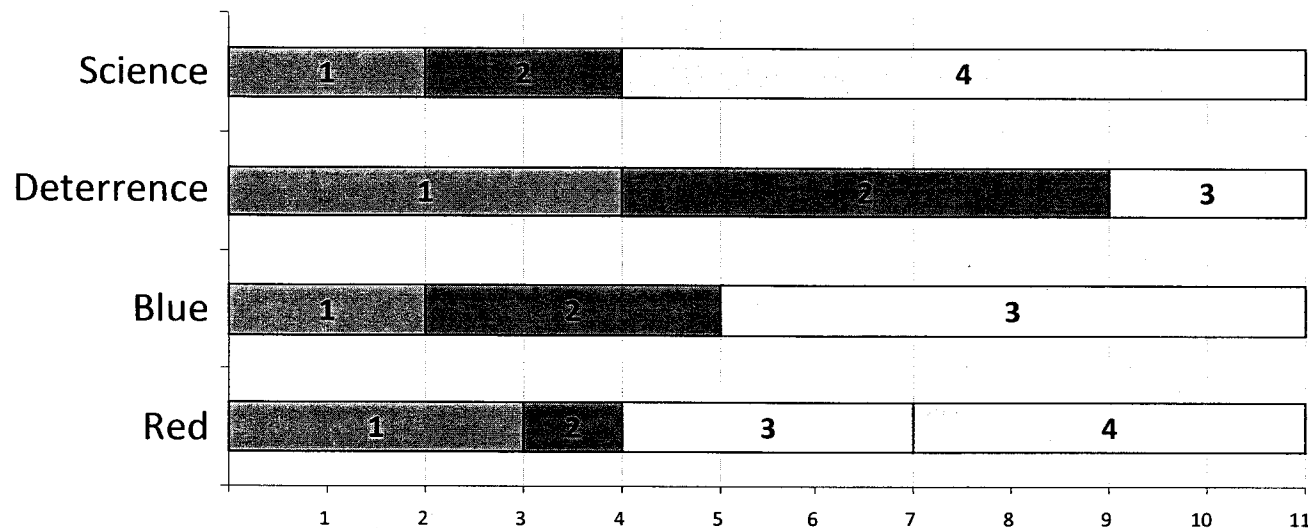
- Collectively covering all four categories of expertise
- Individually covering multiple categories of expertise if possible
- Collectively balanced on views of NMD



Experts' Self-Assessments

During the session, experts ranked themselves across categories

- 1 through 4
 - 1 = I know this area best, 4 = I know this area least well
- Deterrence was the best-represented category of expertise, followed by Blue, Red, and Science





How Experts Were Asked To Express Uncertainty

Experts were asked to provide their opinions in two formats, numeric and textual

- Numerical responses were primarily given in terms of ranges (intervals) of probabilities ("How likely is it?") that a particular event would occur under the circumstances expressed in the scenario
- Textual responses were given as explanations ("Why?") of their numeric responses
- Free-form discussion followed each of two rounds of formal elicitation

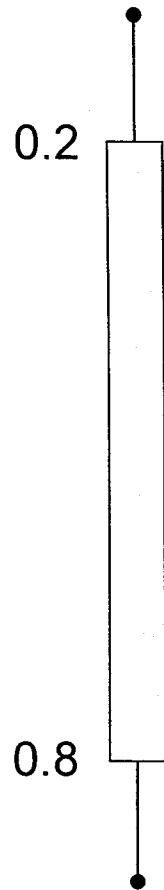
Experts were introduced to the idea of probability intervals

- "We don't assume that you know the answers for certain. Working with 90% probability intervals means that the high and low figures you choose should contain the true value 90% of the time. The more certain you feel about the answer, the smaller your interval should be; the less certain you feel, the bigger it should be.
- "For each question:
 - You may give your best estimate, and then the high and low figures.
 - You may give the high and low figures, and then your best estimate.
 - You may give the high and low figures only. (We'll assume your best estimate is right in the middle.)
 - You may decide not to respond at all.
- "You can answer with one significant digit (e.g., 0.5) or more (e.g., 0.25)."

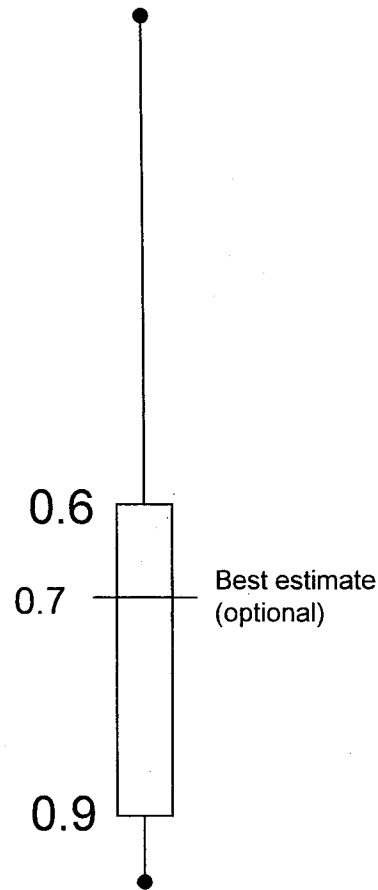
Examples shown to the experts appear on the next slide



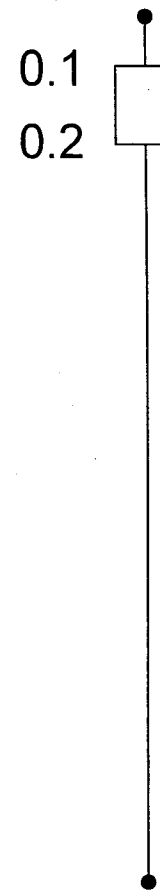
Examples of Probability Intervals



A large interval: this expert is largely uncertain.



A smaller interval: less uncertain.



An even smaller interval: even less uncertain.



How The Experts Responded

Experts were willing, able to respond to questions about probabilities

- Some showed greater comfort than others in giving quantitative responses, especially at first
- Most preferred to give a range without specifying a non-centered best estimate
 - Three of the four experts who assessed “Science” as one of their top two categories of expertise volunteered any non-centered best estimates
 - Two of the seven experts who assessed “Science” as their fourth category of expertise volunteered any non-centered best estimates, one of them only once

Qualitative responses posed no difficulties

- All experts were able to supply rationales and could express ideas intuitively in terms of likelihood

Almost all experts responded to all questions

- Technical
- Political-military
- Technical-political-military



Expert Participants



- Gary Bartnick Johns Hopkins University
- Elaine Bunn National Defense University
- Philip Coyle World Security Institute
- Steve Fetter University of Maryland
- Michael Gerson CNA Corporation
- Evan Medeiros RAND Corporation
- Derek Mitchell Center for Strategic and International Studies
- David Mosher RAND Corporation
- Baker Spring Heritage Foundation
- Michael Swaine Carnegie Endowment for International Peace
- Christopher Twomey Naval Postgraduate School

(See appendix for biographies.)



Analysis: Key Questions

What cumulative probabilities did the experts assign to the escalation process?

- How much did experts differ?
 - How much their best estimates differ?
 - How much did their ranges (i.e., widths) of probability intervals vary?
- Did expert specialization influence any responses?

What sources of uncertainty were important to the experts?

- How important was uncertainty about NMD, compared to other factors?
- When in the scenario did NMD matter most?

Did the responses suggest potential for misperception?



Cumulative Probability of Escalation

- Introduction

- Cumulative Probability of Escalation

- Key Sources of Uncertainty

- Potential for Misperception

- Conclusions

- Appendix: Participant Biographies



Experts Saw Probability of Escalation as Low

The cumulative probability of escalation is shown on the following slide

- Shows the range of values across all experts from E1 (Red Attacks) to E9 (Red Retaliation)
 - Maximum values, best estimates, and minimum values (all given with 90% confidence) are shown separately
 - The median response in each category is shown, with trendlines for emphasis

Escalation to nuclear use emerged as unlikely

- Regardless of experts' views on NMD, the far reaches of the scenario appeared remote
 - Most experts' responses cumulatively produced less than 1% chance, even assuming the initiating event were to occur
 - Most experts also considered the initiating event (E0) as unlikely
 - Cumulative differences between experts also compress as the scenario progresses

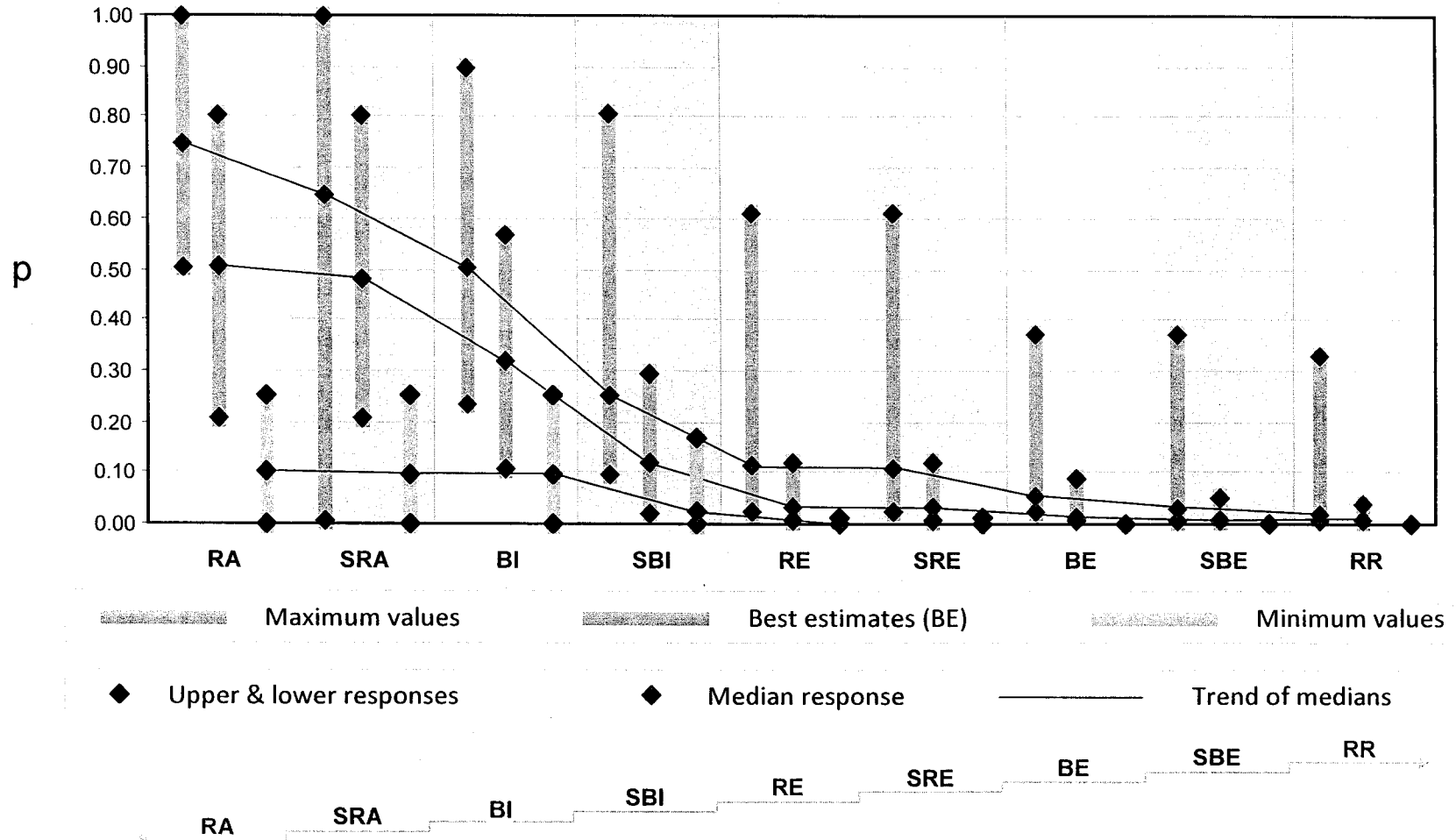
Despite the impression of consensus, there were considerable differences

- Experts always varied, even after questions had been explained and clarified
 - One expert's responses cumulatively produced a maximum probability of >30% of escalation to nuclear use
- Qualitative (text) responses identified as important certain factors that were not specified in the scenario



Cumulative Probability of Escalation Falls Off Early

Cumulative Probability of Escalation: Range of Values across Experts

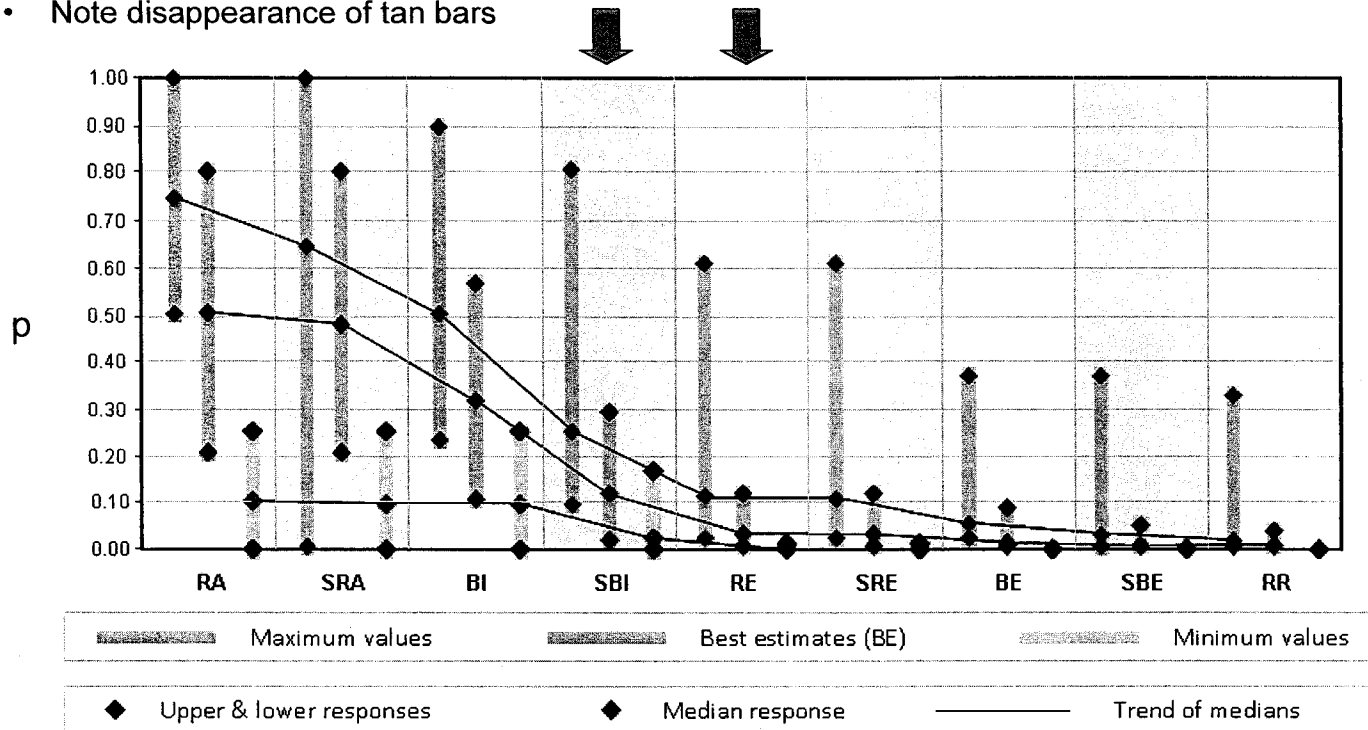




Observations on Cumulative Probability of Escalation

A sharp fall-off in cumulative probability occurs across events

- An inflection point occurs at Success of Blue Intervention (SBI) and Red Escalation (RE)
 - At RE, median best estimate = 0.03
 - At RE, all experts' minimum values are at or near zero (uppermost = 0.01)
- Note disappearance of tan bars

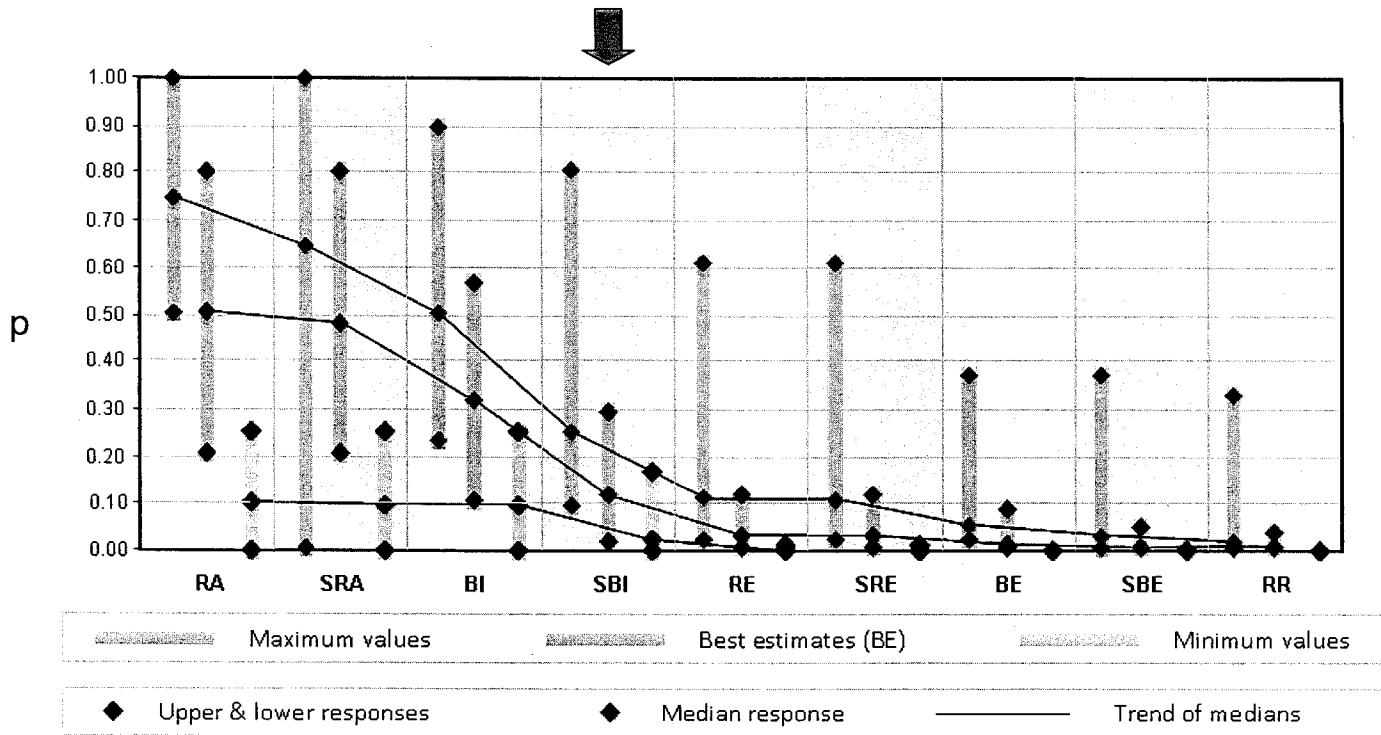




Observations on Cumulative Probability of Escalation (Ctd)

Cumulative probability intervals also narrow dramatically

- Uppermost maximum values (tops of light blue bars) reflect outlying responses
 - Note increasing distance from median maximum values, starting with Success of Blue Intervention (SBI)





Expert Perspectives on Success of Blue Intervention (SBI)

Most doubted that Blue could decisively foreclose Red options

- Exact question: "In your view, how likely is Blue's intervention to have forced Red to choose between ceasing operations or escalating?"

"If 'escalation' means going to a nuclear response, Red has many better options than crossing the nuclear threshold with tactical nuclear weapons. However, if in battle Blue has trounced Red military forces Red will have to decide between ceasing operations and responding to the trouncing in some manner that does not involve nuclear forces."

"Escalation (given possible Blue retaliation) or ceasing ops (backing down militarily, given the emphasis Red has placed on Green non-independence) are both risky for Red, so it would continue to do whatever it could conventionally..."

"Blue can break the blockade, but that doesn't mean Red would be forced to choose between nuclear escalation and capitulation. Red could continue to use conventional missile attacks and use special operations forces to destabilize Green..."



Expert Perspectives on Success of Blue Intervention (Ctd)

"Red would probably have, and want to employ, a variety of other options below the nuclear threshold before escalating (ASAT, etc.). Given Blue nuclear advantages, coupled with their uncertainty about the effectiveness of NMD, Red would likely want to find options to escalate without crossing the nuclear threshold."

"This is the key question of this whole chain. There are some serious doubts about Blue's ability to blunt a Red invasion with carriers carrying the entire tacair load. If you posit that Blue does destroy the Red fleets, Red can always continue to coerce the Green-ese with conventional missile attacks."

"It's very unlikely that Red would go nuclear on Blue or cease operations given the stakes of standing up to Blue and responding militarily in a Green-related scenario..."

"...Red's asymmetrical non-nuclear military capabilities could be effective..."

"Red has a variety of options—including more conventional strikes, cyber and ASAT—before it would need to escalate to a nuclear conflict..."



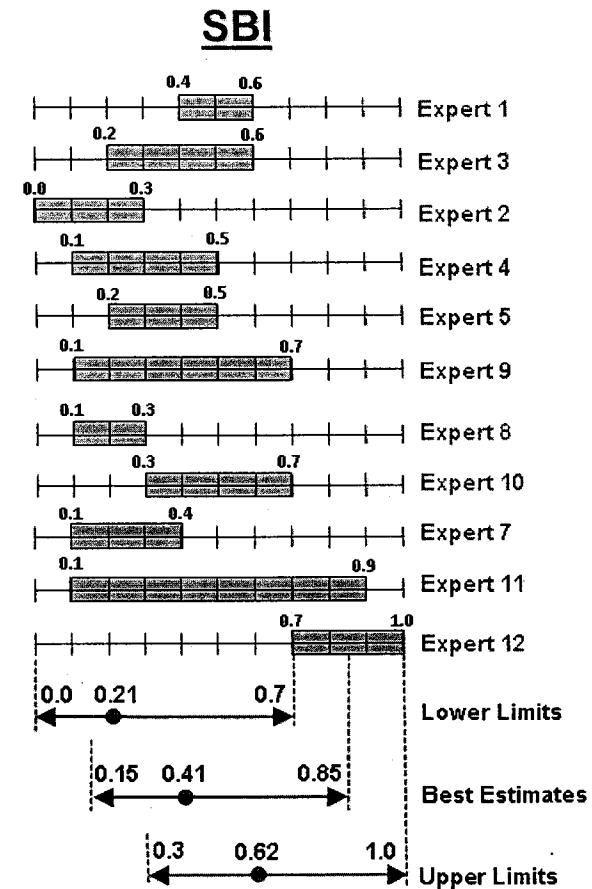
Range of Responses to Success of Blue Intervention (SBI)

The trend in text responses is also apparent in numerical responses

- Mean best estimate of probability = 0.41
 - Eight of 11 experts gave best estimates < 0.5
 - Two of 11 experts gave best estimates = 0.5
 - One of 11 experts gave a best estimate > 0.5

Despite the overall trend, there were considerable differences

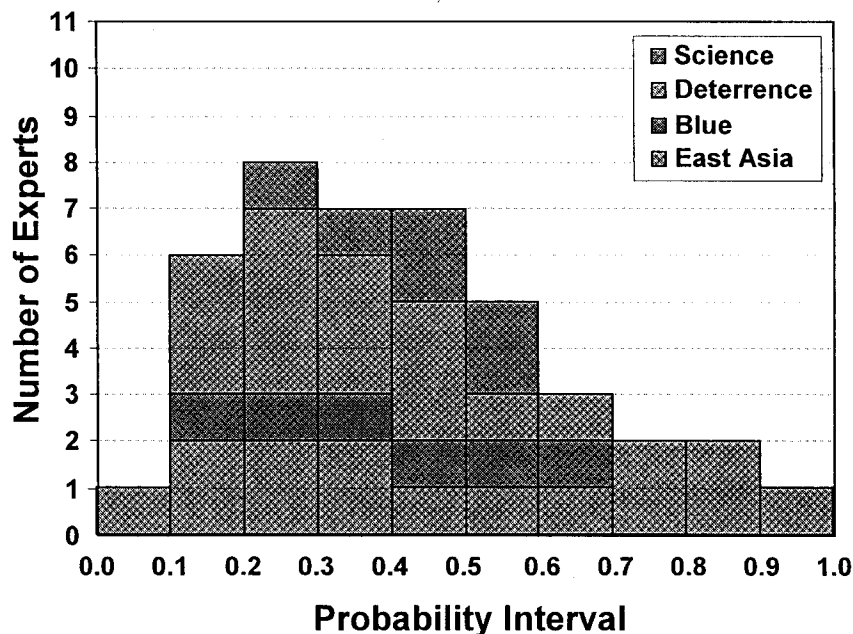
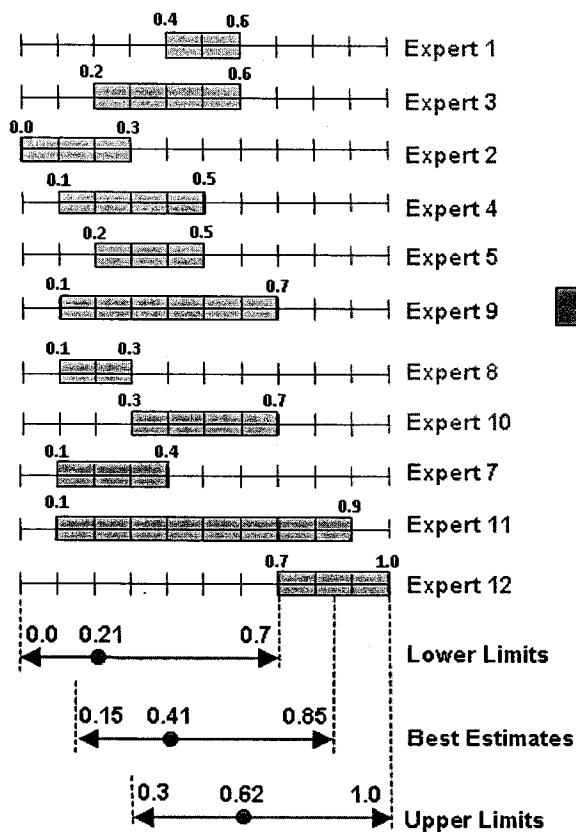
- The ranges of probability intervals supplied by experts extended from 0.2 to 0.8
 - Nine of 11 experts gave ranges < 0.5
 - Two of 11 experts gave ranges > 0.5
- Responses collectively cover the entire scale of probability
 - Lower limits included 0.0 (Expert 2) while upper limits included 1.0 (Expert 12)
 - Best estimates varied from 0.15 (Expert 2) to 0.85 (Expert 12)





Range of Responses to Success of Blue Intervention (SBI) (Ctd)

“In your view, how likely is Blue’s intervention to have forced Red to choose between ceasing operations or escalating?”



The uncertainty surrounding the main trend of responses is non-trivial.



Expert Perspectives on Red Escalation

Most doubted Red would resort to nuclear use unless the Red regime, or Red's retaliatory capability, was threatened

- Exact question: "How likely is Red to escalate to a theater nuclear attack against Blue naval forces?"

"...only if [the capability to attack carriers conventionally] has been totally attrited by Blue conventional attack or has already proven ineffective due to Blue ship defense will Red be forced to choose between capitulation and escalation, the latter being less likely than the former."

"...Red has many better options, typically shows great patience, and the willingness to wait 50 or 100 years for their desired outcome."

"Assuming Blue conventional strikes only opposite Green [i.e., in Red coastal areas], I'm not sure they'd actually use nukes against a Blue carrier. Maybe a demonstration shot under the guise of a nuclear test? To say we're really serious, our stakes are higher?..."

"It's extremely unlikely that Red would go up the nuclear escalatory ladder, given the clear provocation to Blue to respond in kind. The only possibility is if Red seeks to play the dangerous game of demonstrating its absolute commitment to Green..."



Expert Perspectives on Red Escalation (Ctd)

“There is no Red path to ‘victory’ by launching nuclear attacks against the Blue Navy, and the risks of escalation—leading to the destruction of the Red state—would be recognized in advance as enormous. Red can continue to harass and pressure Green through conventional missile strikes even after the blockade is broken.”

“Red’s motivation to cross the nuclear threshold largely depends on whether they believe that losing Green would mean the end of the legitimacy of the ruling regime. If Red leaders believe that they can stay in power even if they lose the conventional conflict, nuclear escalation is unlikely...”

“The Red-ians are unlikely to escalate to this level unless they are gravely concerned about the survival of the regime (the Party) or the survivability of their nuclear force. Other nuclear options short of attacking battle groups include a demonstration shot at sea, an underground nuclear test, etc. If Blue satellites have not yet been attacked, that is also an escalation option. These provide options for demonstrating resolve and red lines without inviting a Blue nuclear response.”



Expert Perspectives on Red Escalation (Ctd)

"It's unlikely that Red will cross the nuclear threshold unless Blue threatens to neuter their nuclear capabilities—not just eliminating their Navy. Starting a nuclear war with Blue is such a dangerous option that it would not be undertaken unless in the most extreme of circumstances. The Red leadership could be defeated in a Green conflict over the short term but still remain in power under the rationale—promoted by a massive propaganda campaign—that they fought hard, and will retrench to fight another day. Crossing the nuclear threshold is a much riskier option and one with unclear gains for Red (and the ruling party)."

"The likelihood of a Red nuclear response depends heavily on how extensive Blue conventional attack might be. If Blue is appearing to eliminate the Red command and control over both conventional and strategic forces, and is wreaking a level of havoc on the current leadership in the Red capital that threatens its survivability, then it will likely seek to shut down Blue attack using whatever means necessary (within the theater). If Blue attack is more limited, the chance of a Red nuclear response becomes very low."

"I think without grave pressure on the regime, which Blue would be careful to avoid in earlier rounds, the Red would not cross this line."



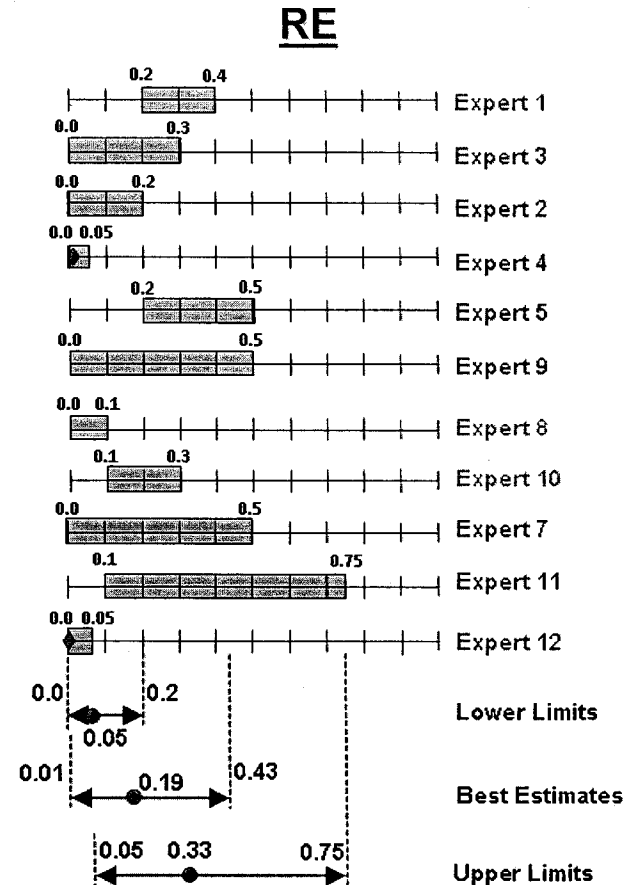
Range of Responses to Red Escalation (RE)

A consensus is apparent in the numerical responses

- Mean best estimate = 0.19
 - All best estimates are < 0.5
 - Eight of 11 experts gave best estimates ≤ 0.25
- Only one upper limit is > 0.5

Despite the overall trend, there were differences

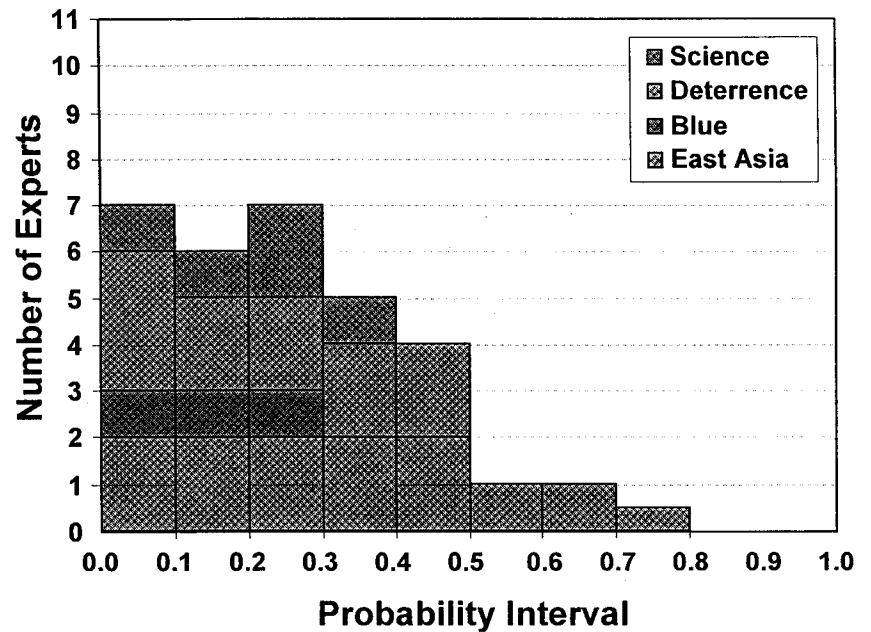
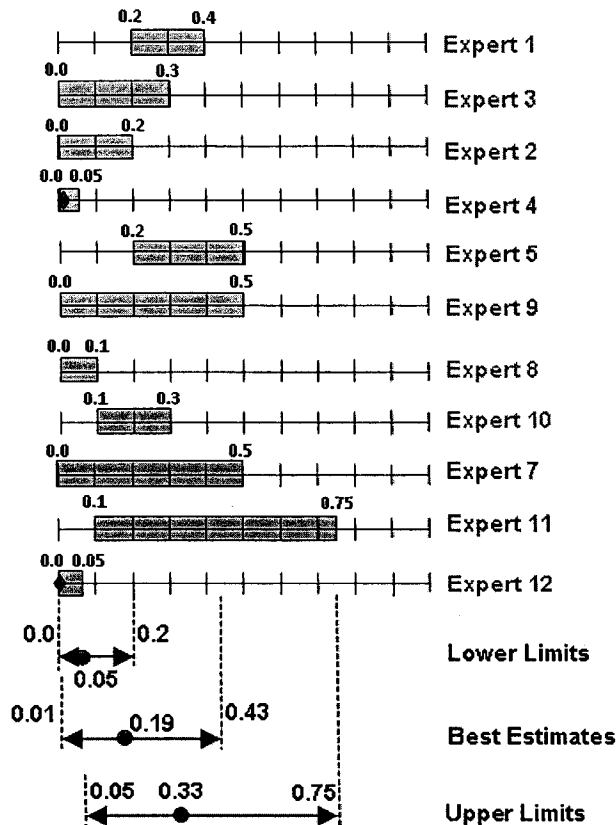
- The ranges of probability intervals supplied by experts extended from 0.05 to 0.65
 - Nine of 11 experts gave ranges < 0.5
 - Two of 11 experts gave ranges $\Rightarrow 0.5$
- Responses collectively cover $\frac{3}{4}$ of the scale of probability
 - Lower limits included 0.0 (7 experts) while upper limits included 0.75 (Expert 11)





Range of Responses to Responses to Red Escalation (RE) (Ctd)

“How likely is Red to escalate to a theater nuclear attack against Blue naval forces?”



The range of responses is apparent.



The “Red Expert” Perspective

Experts on regional affairs had a distinctive view on specific pol-mil issues

- In the view of experts who gave “Red” as their top area of expertise, Blue is highly committed to intervening *with conventional arms* in the event of an armed conflict between Red and Green
 - A typical observation:

“A Red use of force against Green, even if Green defied Blue requests to limit its pro-independence proclamations, would prompt a Blue response. Blue interests in a Red use of force in the region would involve broader Blue regional security interests than just a Green question—increasing Blue incentive to intervene.”

- “Red experts” were also the most sensitive to scenario details, and were the most likely to take issue with aspects of the scenario on grounds of realism



Key Sources of Uncertainty

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Key Uncertainties: NMD vs. Nuclear Deterrence

There were multiple, competing perspectives on how much NMD influences Red's decision whether to retaliate (RR)

Some experts saw nuclear deterrence as entirely outweighing NMD:

"If Red were reckless enough to decide to attack [the Blue homeland with nuclear forces], the presence or absence of Blue MD would not change that."

"Missile defense will have little effect on this calculation relative to massive retaliation, which they [i.e., the Red leadership] would have to expect."

"[G]enerally, the range is on the low side as I would expect Blue to emphasize, and the Red side to understand, the potential for a follow-on countervalue strike."



Key Uncertainties: NMD vs. Nuclear Deterrence (ctd.)

Others saw NMD as relevant at this extreme point:

"The probability of Red retaliation depends on several factors, including their perception of their ability to penetrate Blue defenses, their desire to continue the conflict after absorbing a Blue counterforce attack, their ability to actually launch an attack after absorbing that attack, and their assessment of what they have to gain (or lose) by attacking Blue."

"Blue has conducted a full-scale counter-force nuclear attack against Red... Blue would do this only if it believed that it has a 100% effective NMD system and could shut down Red's other forms of serious retaliation... if that has occurred, Red, in this new world, could choose to retaliate against the homeland in a limited manner, probably only attacking counter-force targets. But it would need to balance a desire for retaliation against a likely strong belief that Blue could intercept its attack with NMD (otherwise, why would Blue have attacked in the previous move?)."



Key Uncertainties: NMD vs. Nuclear Deterrence (ctd.)

Late-stage decision-making simply seemed unpredictable to many:

“Red would be confused and devastated—militarily, economically, politically and socially—by a Blue nuclear strike. It would take them days if not weeks to understand the extent of the destruction. The leadership would likely be dispersed and it would take them several days to reconnect. It’s not clear how long it would take Red to reconstitute the strategic command and control to make a decision of how to retaliate—to pull the political-military leadership body together again.”

“Many issues seem relevant here; as in some of the other decisions, MD uncertainty is among them, but not central. A key issue for me is the nature of C2 in Red after Blue strike. Is there a significant role for civilian leaders afterwards? Have they been killed? Pushed aside?”

“Outside observers/analysts of Red do not have enough information to judge the calculations of Red leaders under such extreme duress. We don't have the insights into leadership dynamics, civil/military relations, decision-making, and crisis management to know with any certainty where this would all end up.”



Key Uncertainties: The Role of Conventional Forces

To many, the conventional balance of forces played a larger role in assuring Blue's freedom of action than either nuclear forces or NMD:

"It is highly unlikely that Blue would feel forced into a nuclear escalatory ladder when it has substantial conventional forces to bear on Red. It is likely, however, that Blue would impose a severe cost on the Red mainland in a precise counter-force manner to limit the damage to civilians while staying within the nuclear threshold at this point."

"A massive Blue counterforce strike would represent a huge escalation given that it is in response to a tactical nuclear weapons attack against Blue Navy ships and nothing more. Any sane Blue President would look for a more proportional response. This response would be with conventional forces if possible, and against limited military targets."

"There are many options open to Blue other than a large scale nuclear counterforce strike, many of which are more likely. Blue could ignore the nuclear attack and continue to prosecute the conventional conflict, threatening retaliation if Red strikes again. Or it could launch a nuclear attack against a parallel military target, such as Red naval concentrations, bases, or air bases."



Key Uncertainties: The Role of Stakes

Many saw the Red leadership's willingness to cross the nuclear threshold as contingent on perception of an immediate threat to the survival of the regime:

"Starting a nuclear war with Blue is such a dangerous option that it would not be undertaken unless in the most extreme of circumstances."

"If Blue ... is wreaking a level of havoc on the current leadership in the Red capital that threatens its survivability, then it will likely seek to shut down Blue attack using whatever means necessary (within the theater). If Blue attack is more limited, the chance of a Red nuclear response becomes very low."

"Red's motivation to cross the nuclear threshold largely depends on whether they believe that losing Green would mean the end of the legitimacy of the ruling regime."

"I think without grave pressure on the regime, which Blue would be careful to avoid in earlier rounds, the Red would not cross this line."



Key Uncertainties: The Changing Weight of NMD

Overall, the later in the crisis, the more weight NMD carried

- Original assessments of decisions were given under conditions of uncertainty about NMD performance (“Phase A”)
- Experts were then asked to rescore their assessments assuming completely ineffective NMD (“Phase B”) and completely effective NMD (“Phase C”)
 - About half the experts saw NMD as having no effect on Red’s decision whether to use strategic nuclear weapons at the end of the scenario (RR)
 - Almost all experts saw NMD as having no effect on Red’s decision whether to use force against Green (RA)

How many experts (out of 11) did not vary their response from Phase A

	RA		B		RR		RR		RR	
	Red	Blue	Blue	Red	Red	Blue	Blue	Red	Red	Blue
Phase B	9	9	7	8	8	7	5	4	4	5
Phase C	8	9	7	7	9	8	5	5	5	4

“[F]urther away from the heights of the escalatory ladder, MD issues would seem relatively abstract and would play a smaller role.”



Potential for Misperception

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Is There Potential for Misperception?

Miscalculated escalation could lead to unwanted war

- One side may believe it can escalate without provoking further escalation
- How the other side responds determines whether the escalation was miscalculated

A positive "perception gap" would indicate overconfidence, with potential for miscalculated escalation

- The perception gap is treated at each decision node as the difference between experts' judgment
 - of the chance of escalation and
 - of the other side's expectation of escalation

		Blue's view	
		Yes	No
Red's view	Yes	No gap	Negative gap – Red is conservative
	No	Positive gap – Red is overconfident	No gap



Overall Potential for Misperception Appeared Modest

The perception gap tended to expand as the scenario moved to higher levels of violence, but was mostly negative

- Perception gap for median best estimates:
 - RA: -0.09, BI: 0.03, RE: -0.13, BE: -0.15, RR: -0.12
- The generally negative gap (including at RE) indicates conservative thinking, not a tendency towards miscalculated escalation
- Tendency towards conservatism is slightly reinforced when Red / Blue experts are cast in those roles

Perception gap (range of all responses and mean of all responses)

	RA		BI		RE		BE		RR	
	Red	Blue	Blue	Red	Red	Blue	Blue	Red	Red	Blue
Lower Limits	0.0–0.5, 0.23	0.1–0.5, 0.32	0.1–1.0, 0.57	0.3–0.9, 0.55	0.0–0.2, 0.05	0.0–0.3, 0.16	0.0–0.85, 0.18	0.05–0.8, 0.37	0.0–0.3, 0.1	0.1–0.7, 0.3
Best Estimates	0.1–0.75, 0.47	0.3–0.75, 0.56	0.4–1.0, 0.73	0.5–0.95, 0.7	0.01–0.43, 0.19	0.02–0.55, 0.32	0.01–0.9, 0.37	0.2–0.85, 0.52	0.0–0.5, 0.3	0.4–0.85, 0.52
Upper Limits	0.25–1.0, 0.7	0.5–1.0, 0.79	0.6–1.0, 0.85	0.7–1.0, 0.86	0.05–0.75, 0.33	0.05–0.8, 0.49	0.1–0.95, 0.59	0.5–1.0, 0.7	0.1–0.9, 0.54	0.5–0.99, 0.74



Discussion Did Reveal Lingering Concern About Overconfidence

Some experts saw official statements about the July 2006 North Korean missile test as showing potential to mislead U.S. leadership about uncertainty surrounding NMD's effectiveness

"It's not a perfect system; it never will be," said one person familiar with the issues involved, speaking on condition of anonymity while discussing internal deliberations. Officials are debating whether the system now is good enough to provide "a high probability" of success, he said.

"They're some who think that it is, and some think it isn't."

Los Angeles Times, June 22, 2006

"Based on the testing that has been done to date, I am confident that we would hit a long-range missile that was fired at the United States,' [MDA Director Henry Obering] said."

AFP, July 5, 2006

"Yeah, I think we had a reasonable chance of shooting it down. At least that's what the military commanders told me,' [President] Bush said at a news conference."

AFP, July 6, 2006



Conclusions

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Recapitulation of the Findings

Escalation to nuclear use emerged as unlikely overall

- Regardless of experts' views on NMD, the far reaches of the scenario appeared remote—but this view was not unanimous
- Especially in the view of experts who gave “Red” as their top area of expertise, Blue is highly committed to intervening *with conventional arms* in the event of an armed conflict between Red and Green
- Nevertheless, most experts doubted that Blue’s conventional forces could decisively foreclose Red options, forcing a choice between capitulation and resort to theater nuclear weapons
 - “Red has many better options than crossing the nuclear threshold with tactical nuclear weapons.”

Red escalation to nuclear use could depend on Blue targeting decisions in a conventional conflict

- In the event, most doubted Red would resort to nuclear use unless the Red regime, or Red’s retaliatory capability, was threatened by Blue’s use of conventional forces



Recapitulation of the Findings (Ctd)

There was no consensus on whether NMD would influence Red's decision whether to retaliate (RR) in the event of a strategic nuclear attack

- Some experts saw nuclear deterrence as entirely outweighing NMD
- Others saw NMD as relevant at this extreme point
- But late-stage decision-making also seemed unpredictable to many

Some experts saw factors as outweighing uncertainty about NMD performance in Red and Blue decisions

- Conventional forces: To many, the conventional balance of forces played a larger role in assuring Blue's freedom of action than either nuclear forces or NMD
- Stakes: Many saw the Red leadership's willingness to cross the nuclear threshold as contingent on perception of an immediate threat to the survival of the regime

In general, the later in the crisis, the more weight NMD carried

- About half the experts saw NMD as having no effect on Red's decision whether to use strategic nuclear weapons at the end of the scenario (RR)
- Almost all experts saw NMD as having no effect on Red's decision whether to use force against Green (RA)

The potential for misperception (inviting miscalculated escalation) appeared modest

- However, some experts saw official statements about the July 2006 North Korean missile test as showing potential to mislead U.S. leadership about uncertainty surrounding NMD's effectiveness



Concluding Observations About the Elicitation Procedure

A structured approach gave more trustworthy results than free-form discussion alone

- Independent responses equalized the participation of all experts, minimized the influence of social factors, and exposed differences that otherwise might be obscured
 - “Social factors” include seniority, prestige, perceived superior expertise, strength of personality
 - The need for clarification of questions did not make it possible to isolate experts completely

Using both numerical and text responses gave advantages over either approach alone

- Numerical (quantitative) responses made the experts’ opinions comparable to each other
 - Verbal expressions of probability (e.g., “likely”) mean different things to different people
- Numerical responses made it possible to calculate cumulative probability of escalation
- Text (qualitative) responses made the experts’ opinions transparent
 - These responses, supplemented by free-form discussions afterwards, exposed *why* each expert gave their response, and provided insights into the key uncertainties
 - Text responses also surfaced confusion or conflicting understandings of the questions, allowing for clarification

Tackling this scenario with this approach was ambitious and demanding

- A one-day event with 11 expert participants could have easily been a multi-day event involving 6-12 experts in each of the four key areas of knowledge involved



Appendix: Participant Biographies

- Introduction
- Cumulative Probability of Escalation
- Key Sources of Uncertainty
- Potential for Misperception
- Conclusions

- Appendix: Participant Biographies



Expert Participants

- Gary Bartnick Johns Hopkins University Applied Physics Laboratory
- Elaine Bunn National Defense University (Institute for National Strategic Studies)
- Phil Coyle World Security Institute
- Steve Fetter University of Maryland (School of Public Policy)
- Michael Gerson CNA Corporation
- Evan Medeiros RAND Corporation
- Derek Mitchell Center for Strategic and International Studies
- David Mosher RAND Corporation
- Baker Spring Heritage Foundation
- Michael Swaine Carnegie Endowment for International Peace
- Chris Twomey Naval Postgraduate School (Center for Contemporary Conflict)

The following biographies are current as of December 2, 2008.



Gary Bartnick

- Gary Bartnick is a National Security Studies Fellow of the Johns Hopkins University Applied Physics Laboratory, having joined that institution in 1964. He has an extensive background in weapon system test and evaluation and in strategic analysis. His experience includes planning, conducting and evaluating tests of strategic weapon systems (the Navy's Polaris and Poseidon), tactical weapon systems (the Army's PERSHING I, Ia, and II variants and LANCE system, and the Air Force Ground Launched Cruise Missile), and tests and experiments applicable to ballistic missile defense; leading the specification, development and utilization of advanced analytic methodologies for the assessment of offensive weapon system reliability, accuracy, and pre-launch survivability and for projecting defensive weapon system protection effectiveness; and adapting those analytic tools and methodologies to the analysis of strategic deterrence. He holds a B.S in Physics, 1964, with graduate study in Space Science and Astrophysics, 1964-1969.



Elaine Bunn

- M. Elaine Bunn is a distinguished research fellow at the Institute of National Strategic Studies at the National Defense University. She leads an INSS project assessing future strategic capabilities and concepts. Before joining INSS, she held a number of policy management and analysis positions in the Office of the Secretary of Defense beginning in 1980. She served as Principal Director, Nuclear Forces and Missile Defense Policy, in the Office of the Assistant Secretary of Defense for Strategy and Threat Reduction from 1993-98. During that time, she directed the 1994 Nuclear Posture Review. Her other assignments in OSD include Staff Analyst, Deputy Director, and Acting Director in the Office of Strategic Defense Policy, Staff Analyst, Strategic Arms Control Policy, and Staff Analyst, Theater Nuclear Forces Policy. Ms. Bunn was with the RAND Corporation 1998-2000 on a DoD exchange assignment. From February through June 2001, she co-chaired a nuclear panel for the Secretary of Defense, framing issues for the 2001 Nuclear Posture Review.



Phil Coyle

- Philip E. Coyle, III is a Senior Advisor to the President of the World Security Institute, and to its Center for Defense Information, a Washington D.C.-based national security study center. He is a recognized expert on U.S. and worldwide military research, development and testing, on operational military matters, and on national security policy and defense spending. Coyle also has extensive background in missile defense, in military space systems, and in high-technology weapons, such as high-power lasers and other directed-energy weapons. From his many years at Lawrence Livermore National Laboratory, Coyle also has considerable experience in nuclear weapons research, development, and testing, and nuclear weapons effects, including EMP. From Sept. 29, 1994, through Jan. 20, 2001, Coyle was assistant secretary of defense and director, Operational Test and Evaluation, in the Department of Defense, and is the longest-serving director in the 20-year history of the office. In this capacity, he was the principal advisor to the Secretary of Defense on test and evaluation at DOD.



Steve Fetter

- Steve Fetter is dean of the Maryland School of Public Policy, where he has been a professor since 1988. His research interests include arms control and nonproliferation, nuclear energy and releases of radiation, and climate change and carbon-free energy supply. He has been an advisor to many government agencies, NGOs, and scientific organizations, and has held visiting positions at Stanford, Harvard, and MIT. He holds a Ph.D. in energy and resources from the University of California, Berkeley, and an S.B. in physics from MIT.



Michael Gerson

- Michael S. Gerson is a member of the research staff in the Strategic Initiatives Group at CNA. His research focuses on nuclear and conventional deterrence, WMD proliferation, arms control, international relations theory, diplomatic history, and military strategy. Since joining CNA in September 2006, he participated in the conceptual development of the U.S. Navy's new Maritime Strategy, entitled, "A Cooperative Strategy for 21st Century Seapower," and regularly provides research and analysis on nuclear/conventional deterrence and WMD proliferation to Navy leadership. He received a BA in History from the University of Texas and an MA in International Relations from the University of Chicago.



Evan Medeiros

- Evan S. Medeiros is a Senior Political Scientist at the RAND Corporation, based in Washington, DC. He has authored or co-authored multiple studies and monographs on China's international behavior, Chinese WMD nonproliferation policies, and China's defense industry and Chinese military modernization. He holds a Ph.D. in international relations from the London School of Economics and Political Science; a M.Phil. in international affairs from the University of Cambridge, UK; (where he was a Fulbright Scholar), an M.A. in China Studies from the University of London's School of Oriental and African Studies (SOAS), and a B.A. in analytic philosophy from Bates College in Lewiston, ME. He travels to Asia frequently and speaks, reads, and writes Mandarin Chinese.



Derek Mitchell

- Derek J. Mitchell is senior fellow and director for Asia in the CSIS International Security Program (ISP), having joined the Center in January 2001. Mitchell concurrently serves as director of CSIS's Southeast Asia Initiative, which was inaugurated in January 2008 and is the Center's first dedicated program to the study of Southeast Asian affairs. Mitchell is responsible for managing all Asia-related studies conducted in ISP. Mitchell was special assistant for Asian and Pacific affairs in the Office of the Secretary of Defense from 1997 to 2001. He was the principal author of the Department of Defense (DOD) 1998 East Asia Strategy Report. He is the author of numerous policy-related articles and studies on Asian security affairs and U.S.-Asia relations, including the coauthor of *China: The Balance Sheet—What the World Needs to Know Now about the Emerging Superpower* (PublicAffairs, 2006), and *China's Rise: Challenges and Opportunities* (Peterson Institute Press, 2008).



David Mosher

- David Mosher is a Senior Policy Analyst at the RAND Corporation, based in Washington, DC. He also teaches a course at Georgetown University on the technology of missiles and missile defense. His research currently focuses on nuclear strategy; missile defense; military space; proliferation; terrorist acquisition of nuclear, biological, chemical (NBC) and radiological weapons; deterring and responding to the use of NBC weapons in regional conflicts; individual preparedness for catastrophic terrorism; and Army planning for homeland security. He was the study director of the American Physical Society's 2003 report on boost-phase defense. Before his tenure with the RAND Corporation, David spent ten years in the National Security Division at the Congressional Budget Office conducting research on nuclear weapons and forces, missile defense, and arms control. Prior to joining CBO, David worked at the Johns Hopkins University Applied Physics Laboratory, where he conducted field research on ocean physics and remote sensing.



Baker Spring

- Baker Spring is the F.M. Kirby Research Fellow in National Security Policy at The Heritage Foundation. He specializes in examining the threat of ballistic missiles from Third World countries and U.S. national security issues. In 2005, he developed "Nuclear Games," a table-top exercise to show diplomats from Australia, China, India, Japan, Russia and South Korea the realities of a world where many nations, including rogue states such as North Korea, have nuclear weapons. Spring demonstrated how missile defense systems can strengthen stability and promote peace in such a world. Based on its success, Heritage hosted the first war-gaming exercise on energy security in December 2006. A graduate of Washington and Lee University, Spring received his master's degree in national security studies from Georgetown University.



Michael Swaine

- Michael Swaine is Senior Associate at the China Program of the Carnegie Endowment for International Peace. He came to the Carnegie Endowment after 12 years at the RAND Corporation. He specializes in Chinese security and foreign policy, U.S.-China relations, and East Asian international relations. One of the most prominent U.S. analysts in Chinese security studies, he is the author of more than 10 monographs on security policy in the region. At RAND, he was a senior political scientist in international studies and also research director of the RAND Center for Asia-Pacific Policy. He was appointed as the first recipient of the RAND Center for Asia-Pacific Policy Chair in Northeast Asian Security in recognition of the exceptional contributions he has made in his field. Prior to joining RAND in 1989, Swaine was a consultant with a private sector firm; a postdoctoral fellow at the Center for Chinese Studies, University of California at Berkeley; and a research associate at Harvard University. He attended the Taipei and Tokyo Inter-University Centers for Language Study, administered by Stanford University, for training in Mandarin Chinese and Japanese.



Chris Twomey

- Christopher P. Twomey joined the faculty of the Naval Postgraduate School as an Assistant Professor of National Security Affairs in November 2004. He currently serves as co-director of the Center for Contemporary Conflict and Associate Chair for Research at the department. His manuscript, *The Military Lens: Doctrinal Differences, Misperception, and Deterrence Failure* is currently under review at a university press. He is managing a Track II diplomatic exchange on Sino-American nuclear issues involving senior military officers, academics, and civilian policy makers from both sides. He is also working on a project on East Asian Futures looking at military aspects of great power competition in the region for the Office of Net Assessment, DoD. His research interests center on security studies theories, Chinese foreign policy, strategic culture, statecraft, and East Asian security in theory and practice. He has traveled widely in Asia and lived in China several times. He received a PhD in Political Science from MIT in 2004, a MPIA from the Graduate School of International Relations and Pacific Studies, UC San Diego in 1993, and a BA in Economics from UC San Diego in 1990.

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NMD and Deterrence Concepts

The Influence of Uncertainty about National Missile Defense Performance on Deterrence During a Crisis

June 2009

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Advanced Systems and Concepts Office**

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Introduction

- Introduction
- Understanding the Issues
- Uncertainty and Expert Opinion
- Appendix: Deterrence in Strategic Context



Disagreement and Uncertainty about NMD

Experts agree on very little about NMD

- How effective it is, or can be
- How effective it must be to contribute to national security
- Its probable influence on the course of a future crisis
 - Promoting deterrence?
 - No effect?
 - Encouraging heightened risk-taking?

These disagreements reflect underlying uncertainty

- Little direct, empirical basis is available to support conclusions
- Many perspectives are possible

The relationship between perceptions of NMD effectiveness and the course of crisis has not yet been examined carefully

- What is the likely range of perceptions (between the U.S. and an opponent)?
- What are the effects of that range of perceptions during a crisis?



Policy: "Effective NMD"

It is the policy of the United States Government to deploy an effective, limited National Missile Defense system. Deployment began in 2004.

"It is the policy of the United States to deploy as soon as is technologically possible an **effective** National Missile Defense system capable of defending the territory of the United States against **limited** ballistic missile attack..."

National Missile Defense Act of 1999

"A number of [rogue] states are acquiring increasingly longer-range ballistic missiles as instruments of blackmail and coercion against the United States and its friends and allies. The United States must defend its homeland, its forces and its friends and allies against these threats. We must develop and deploy the means to deter and protect against them, including through **limited** missile defense of our territory."

White House's Announcement of Withdrawal from ABM Treaty (2001)

"The deployment of **effective** missile defenses is an essential element of the United States' broader efforts to transform our defense and deterrence policies and capabilities to meet the new threats we face."

NSPD-23: National Policy on Ballistic Missile Defense (2002)



In Dispute: How Effective Is It?

But how effective NMD actually is, or can be, is subject to dispute, with assessments ranging from 90% effective per salvo to completely ineffective.

90% EFFECTIVE PER SALVO "I had been asked to comment on a particular scenario of which North Korea would launch a missile, a single missile into San Francisco.... Based upon my judgment, I would say given the fact that we could launch one, or two, or three missiles against that target, the effectiveness would be in the 90 percent range."

Under Secretary of Defense Edward (Pete) Aldridge (2003)

OF DOUBTFUL EFFECTIVENESS "Experience with other military systems... suggests that they achieve their best performance only after significant use in combat conditions.... Even if the current NMD system eventually demonstrated a 90 percent rate of technical effectiveness on the test range, it is reasonable to question whether it could ever come close to that under operational conditions."

Former Secretary of Defense William Perry (2001)

OF NO EFFECTIVENESS "Based on the technical capabilities and limitations of the Block 2004 GMD [Ground-based Midcourse Defense] system components, we conclude that there is no technical basis for believing the system will have *any* defensive capability in a real-world attack."

Lisbeth Gronlund, David Wright, George Lewis, and Philip Coyle (2004)



In Dispute: How Effective Must It Be?

Disagreement extends to *how effective NMD must be* in order to contribute to national security.

LESS THAN PERFECT “[D]efenses won’t need to be 100% effective to make a significant contribution to deterrence.”

Under Secretary of Defense Douglas Feith (2001)

CLOSE TO PERFECT “Would a U.S. president be willing to take an action that could lead to a nuclear ICBM attack on a major U.S. city even if he or she were 95 percent confident that the NMD system would be 95 percent effective?”

George Lewis, Lisbeth Gronlund, and David Wright (1999)



In Dispute: What Is Its Role in a Crisis?

Experts also disagree widely about the effects of NMD in a crisis. According to different views, NMD promotes deterrence, has no effect, or encourages heightened risk-taking.

PROMOTES DETERRENCE “[D]efense of U.S. territory [and] U.S. ability to strike in response, can bring into better balance U.S. stakes and risks in a regional confrontation and thus reinforce the credibility of U.S. guarantees designed to deter attacks on allies and friends.”

Nuclear Posture Review (2001)

HAS NO EFFECT “Limited NMD would not... restore much leeway to U.S. foreign policy, because its effectiveness would be uncertain and U.S. leaders would still be concerned about the vulnerability of U.S. cities.”

Charles Glaser and Steve Fetter (2001)

ENCOURAGES RISK-TAKING “...NMD, unless it is extremely effective, is likely to raise the risk both of a nuclear attack on the United States and of nuclear weapons striking the United States. These greater risks... are the direct consequence of a greater U.S. willingness to press its interests in a crisis harder.”

Robert Powell (2003)



The Implications of Disagreement

Disagreements about NMD are founded on uncertainty, which allows for a wide range of judgments. This range of judgments may also occur between national leaders, with implications for crisis, escalation, and war.

Uncertainty: incompleteness of knowledge

- Lack of observations
 - No past ballistic missile attacks on the United States
 - Characteristics of opponents' missile systems and attack modes not well-known
 - No past NMD engagements
 - No record of combat performance
 - The relevance of the testing record to actual performance is disputed
- Random or unanticipated phenomena
 - *e.g.*, weather, random defects, inherent system complexity

Uncertainty expands opportunities for divergent perceptions

- Erroneous judgments of effectiveness
- Divergent judgments of effectiveness
- Misperceptions of others' perceptions



Research Questions

Defining the relationship

- What is NMD's relationship to deterrence in a crisis? How can this relationship be defined and analyzed?

Understanding the role of uncertainty

- What is the role of uncertainty in the NMD/crisis deterrence context? How can it be defined and analyzed?

Expert judgment

- How can elicitation of expert judgment help to understand the uncertainties in a crisis scenario? Can this be demonstrated?

Implications for a specific scenario

- What are the implications of uncertainty about missile defense performance, and other forms of uncertainty, in a realistic crisis scenario?

We have sought to demonstrate the value of structured elicitation of expert judgment in bounding uncertainties, making it possible to draw out the implications of uncertainty about NMD in a specific crisis scenario.



Some Issues Not Considered

The study does not seek to define the actual effectiveness of NMD or assess the merits of deployment. Nor does it consider a variety of possible reactions to NMD that could take place over time.

Arms-racing

- Over time, opponents could quantitatively “build over” NMD deployments
- Opponents could qualitatively enhance offensive forces to counteract NMD
- Opponents could develop alternative modes of attack to circumvent NMD

Preventive attack

- Opponents could sabotage or attack NMD system components

Diplomacy

- Opponents could shift the geopolitical context by seeking countervailing alliances, accommodation with the U.S., or arms limitations

Future NMD systems

- Future NMD systems are not fully defined (“spiral development”)

Roles for NMD other than deterrence in a crisis

- *e.g.*, defense against accidental attack



Understanding the Issues

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NMD's Relationship to Deterrence in a Crisis

NMD is intended to reinforce deterrence

"[D]efense of U.S. territory and power projection forces, including U.S. forces abroad, combined with the certainty of U.S. ability to strike in response, can **bring into better balance U.S. stakes and risks in a regional confrontation** and thus reinforce the credibility of U.S. guarantees designed to deter attacks on allies and friends." (2001 NPR)

"What our new adversaries seek is to keep us out of their region, leaving them free to support terrorism and to pursue aggression against their neighbors. By their own calculations, these leaders may believe they can do this by holding a few of our cities hostage. Our adversaries seek enough destructive capability to blackmail us from coming to the assistance of our friends who would then become the victims of aggression..."

"Some states, such as North Korea, are aggressively pursuing the development of weapons of mass destruction and long-range missiles as a means of coercing the United States and our allies. **To deter such threats, we must devalue missiles as tools of extortion and aggression, undermining the confidence of our adversaries that threatening a missile attack would succeed in blackmailing us.** In this way, although missile defenses are not a replacement for an offensive response capability, they are an added and critical dimension of contemporary deterrence." (NSPD-23)

Sources: "Nuclear Posture Review [Excerpts]," globalsecurity.org (2002);
 "NSPD-23: National Policy on Ballistic Missile Defense" (2002)



Balancing Stakes and Risk

Three key assumptions underpin the idea that NMD “can bring into better balance U.S. stakes and risks”

1. Mutual nuclear deterrence involves shared risk
 - Both sides face the possibility of unacceptable harm
 - This does not require that the harm be *equal*
2. A regional crisis involves an asymmetry of resolve (*i.e.*, stakes)
 - A regional actor is likely to have more at stake in its home region than the U.S., and is therefore better prepared to tolerate risk
 - Powell defines resolve as “the maximum risk of suffering a nuclear strike that the state is willing to run in order to prevail”
3. By reducing the level of risk for the U.S. side, missile defenses could offset an unfavorable balance of resolve
 - The idea of “effective resolve” takes into consideration both the level of perceived risk and the level of resolve
 - A favorable balance of effective resolve would permit the U.S. to escalate (*i.e.*, intervene in a regional crisis, or increase the level of violence) even without a favorable balance of resolve *per se*

Source: Powell, “Nuclear Deterrence Theory, Nuclear Proliferation, and National Missile Defense,” *International Security* 27:4 (2003)



The Role of Uncertainty in a Crisis

Crisis outcomes depend on escalation decisions and the interaction of forces

- A side will not escalate a crisis unless its leadership perceives the risk as tolerable
 - A “favorable balance of effective resolve”
 - A decision in favor of escalation therefore appears to presume that
 - The ensuing interaction of forces will have a favorable result, and
 - The other side is unlikely to counter-escalate the crisis to a point beyond what the first side can tolerate

Perceptions, and therefore also escalation decisions, involve uncertainty

- The willingness of each side to escalate during a crisis implicitly depends on how it perceives the balance of effective resolve, which involves:
 - The level of risk to each side, as perceived by each side
 - Partially based on perceived effectiveness of NMD
 - The level of resolve experienced by each side, as perceived by each side
 - *i.e.*, willingness to tolerate risk
- All of these factors are uncertain, allowing for the possibility of miscalculated escalation

Sources: Powell, “Nuclear Deterrence Theory, Nuclear Proliferation, and National Missile Defense; Lebow, *Nuclear Crisis Management: A Dangerous Illusion* (1987)



Miscalculation and Surprise

An opponent's response to escalation can be miscalculated. A limited escalation can be a source of surprise for its victim—or for its initiator.

Miscalculated escalation may lead to unforeseen conflict

- Consists of acting on a misjudgment of an opponent's response to escalation
 - e.g., the U.S. advance to the Yalu River in 1950, Iraq's invasion of Kuwait in 1990
- A post-escalation loss of control may also occur through acts of commanders in the field
 - e.g., use of depth charges to surface a nuclear-armed Soviet sub during the Cuban blockade

Limited-war options are a potential source of surprise

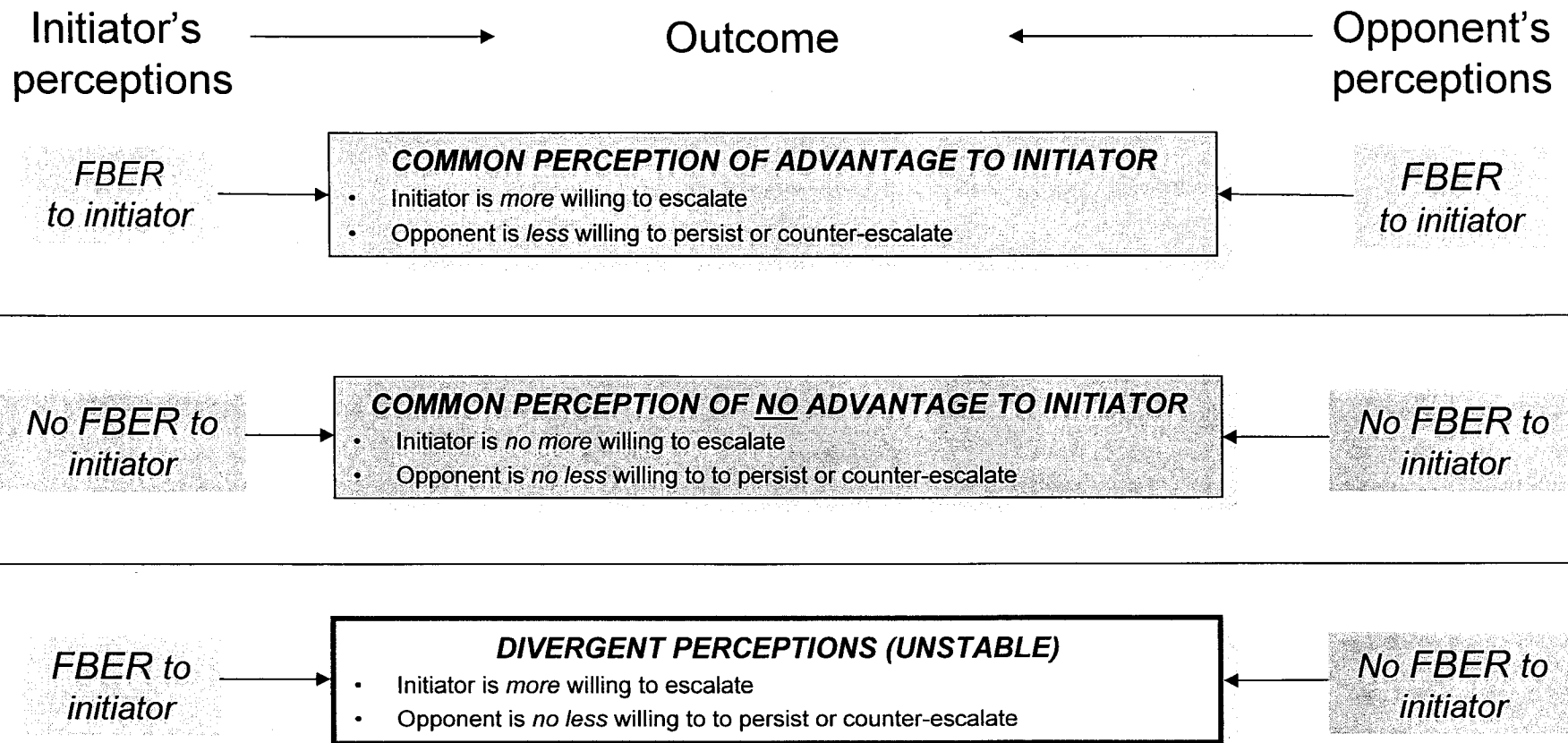
- To manage the risks of escalation, it is possible to “sneak under” or “design around” deterrence through limited objectives, “salami tactics,” 3rd-party targets, or intermediate levels of violence
 - e.g., U.S. blockade of Cuba in 1962, Egypt's invasion of Sinai in 1973, Iraq's conventional missile attacks in 1991, Chinese missile tests in 1996
- Future possibilities include EMP attacks; attacks on an NMD system itself; demonstration attacks that expose NMD ineffectiveness or deplete interceptors; attacks from offshore that complicate attribution; or other creative forms of attack

Sources: Halperin, *Limited War in the Nuclear Age* (1963); Kahn, *On Escalation* (1965); Betts, *Surprise Attack: Lessons for Defense Planning* (1982); Sagan, “Nuclear Alerts and Crisis Management,” *International Security* 9:4 (1985); Jervis, “War and Misperception,” *J. of Interdisciplinary History* 18:4 (1988); Dobbs, *One Minute to Midnight: Kennedy, Khrushchev, and Castro on the Brink of Nuclear War* (2008); Ochmanek and Schwartz, *The Challenge of Nuclear-Armed Regional Adversaries* (2008)



Three Possible Outcomes

Divergent perceptions of whether a potential escalator (“initiator”) enjoys a favorable balance of effective resolve (“FBER”) could be destabilizing.





The Use of a Scenario

The use of a realistic scenario and structured elicitation of expert judgment can aid understanding of how uncertainty about NMD effectiveness can influence the course of a crisis.

The scenario should involve the range of issues identified previously

- A regional crisis involving the U.S. and a nuclear-armed adversary
- A combination of escalation decisions and interactions of forces
- Limited escalation steps, allowing the sides to test each other's effective resolve
- An NMD intercept attempt should occur at or near the end of the scenario, if it escalates to the highest levels of violence

An appropriate setting (i.e., choice of region, actors) is required

- Should involve a realistic crisis situation, about 2-4 years in the future
- Some simplification may be required to isolate key issues and avoid overburdening the elicitation process

Varying assumptions about NMD will give insight into its influence

- Experts will be asked to judge what choices the sides would make if NMD is effective, ineffective, or of uncertain effectiveness
- In the "of uncertain effectiveness" case, experts will be asked to supply their own judgments of NMD performance



Scenario Structure

The scenario is structured as 11 “nodes”

- Six “decision nodes” alternate with five “chance nodes”
 - Decision nodes are escalation decisions by either Red or Blue
 - Chance nodes represent the interaction of forces following a decision to escalate
- Most nodes have strictly binary (either-or) outcomes
 - They either move toward a higher level of violence or “take an off-ramp”
- E8 and E10 have a range of outcomes, but a binary interpretation is used
 - The binary interpretation of E8 and E10: Does Blue escape harm or not?

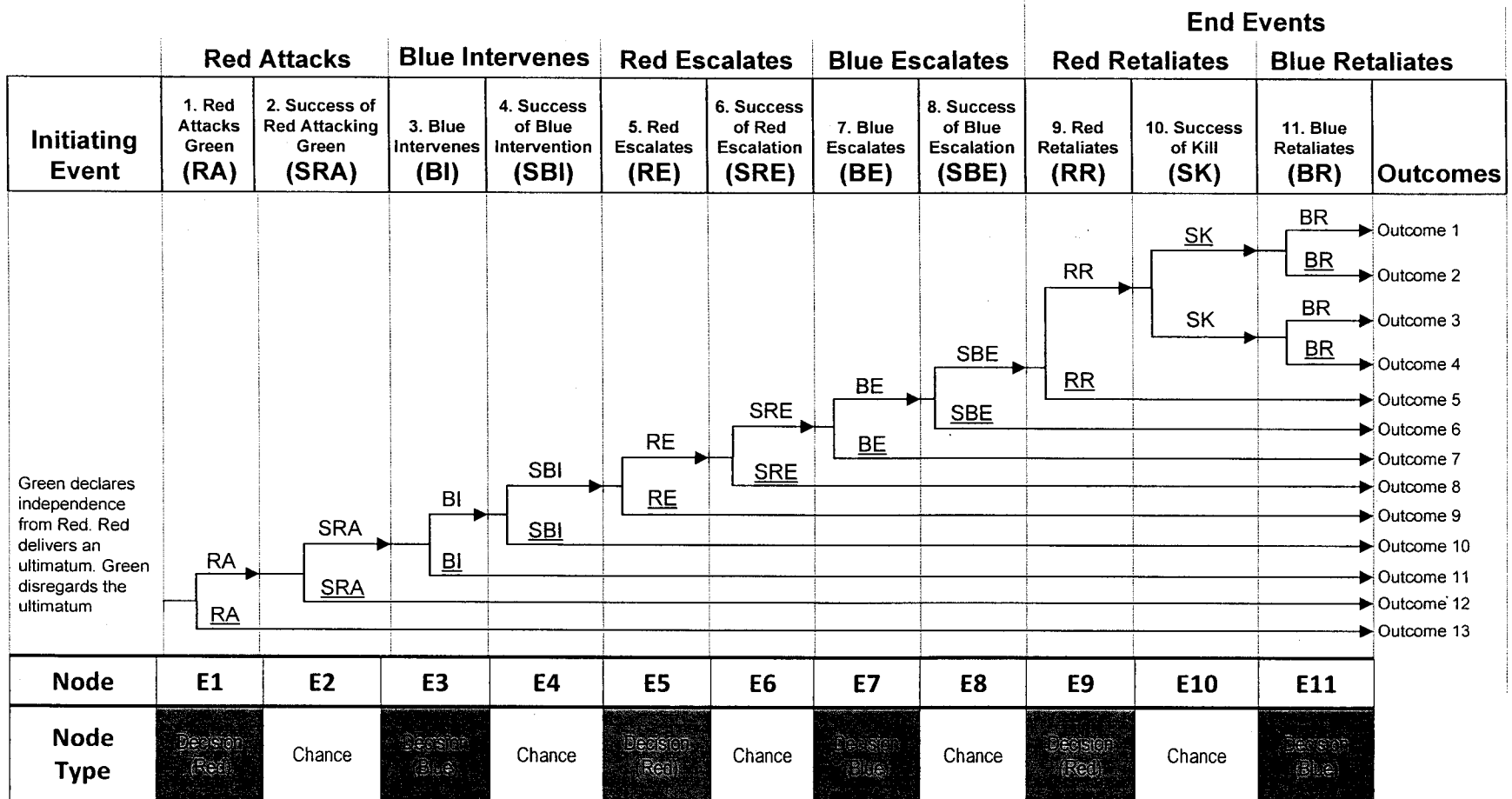
E0		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
Initiating event occurs	Decision nodes: (Red and Blue) Escalate or not?	Decision Red	Chance	Decision Blue	Chance	Decision Red	Chance	Decision Blue	Chance	Decision Red	Chance	Decision Blue
	Chance nodes: (White) What is the outcome of a decision to escalate?	Decision Red	Chance	Decision Blue	Chance	Decision Red	Chance	Decision Blue	Chance	Decision Red	Chance	Decision Blue

Success of Blue escalation (nuclear counterforce attack) →

Success of kill (Blue NMD vs. Red nuclear retaliation) →



The Scenario at a Glance





Uncertainty and Expert Opinion

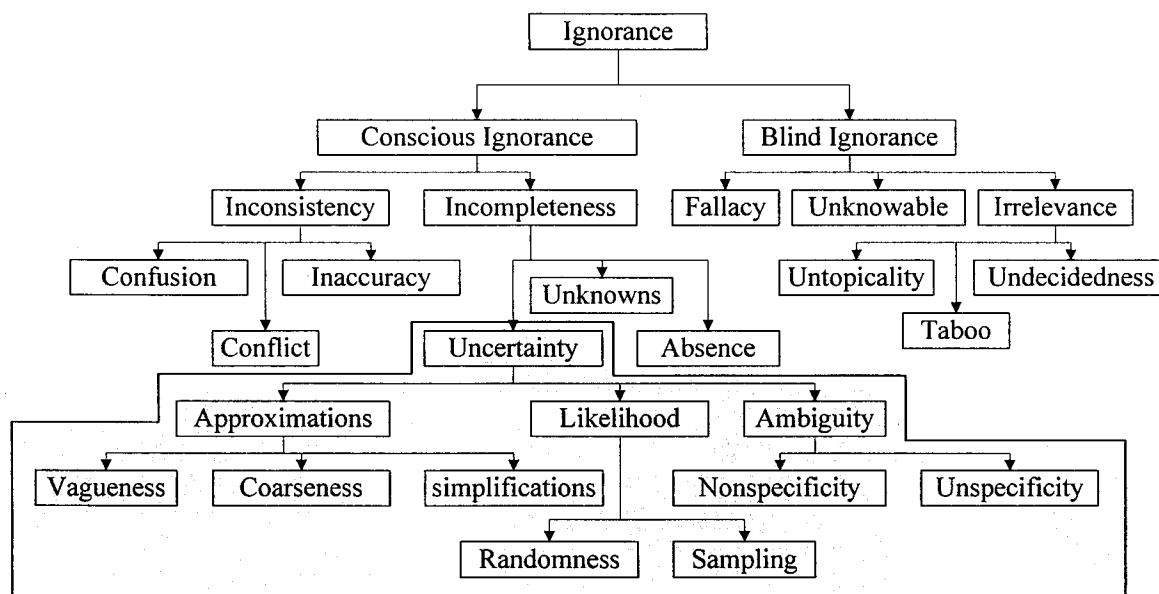
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Defining Uncertainty: A Taxonomy

Uncertainty can be understood as a subset of phenomena under the rubric of ignorance

- In effect, there are multiple sources of uncertainty and other forms of ignorance
- Uncertainty prevails in many areas related to strategic security, creating multiple opportunities for the use of elicitation of expert judgment



Ignorance hierarchy (with uncertainty and its subtypes highlighted).
Source: Ayyub, *Elicitation of Expert Opinions for Uncertainty and Risks* (2001)



Taxonomy: Blind Ignorance

The subtypes of ignorance can be illustrated in terms of strategic security issues

Term	Definition	Examples
1. Blind ignorance	Ignorance of one's own ignorance (or so-called meta-ignorance).	
1.1. Unknowable	Knowledge that cannot be attained by humans based on current evolutionary progressions, or cannot be attained at all due to human limitations, or can only be attained through quantum leaps by humans.	The ability to track submarines in the open ocean from space; the intentions of an adversary who does not yet exist.
1.2. Irrelevance	Ignoring something.	
1.2.1. Untopicality	Intuitions of experts that could not be negotiated with others in terms of cognitive relevance.	An expert's belief in a missile threat to the U.S. from France, the U.K., or other allies.
1.2.2. Taboo	Socially reinforced irrelevance. Issues that people must not know, deal with, inquire about, or investigate.	The idea that the U.S. might strike first with nuclear weapons, without serious provocation.
1.2.3. Undecidedness	Issues that cannot be designated true or false because they are considered insoluble, or solutions that are not verifiable, or <i>ignoratio elenchi</i> [i.e., a logical fallacy or <i>non sequitur</i> – reasoning that does not address the issue at hand].	A counterfactual scenario, e.g., Somali nuclear weapons doctrine.
1.3. Fallacy	Erroneous belief due to misleading notions.	Appeal to authority, circular reasoning, etc.

Source for terms and definitions: Ayyub, 2001



Taxonomy: Inconsistency and Incompleteness

Term	Definition	Examples
2. Conscious ignorance	Recognition of one's own ignorance through reflection.	
2.1. Inconsistency	Distorted information as a result of inaccuracy, conflict, contradiction, and/or confusion.	
2.1.1. Confusion	Wrongful substitutions.	Attribution of data from a ground-based radar trace to a space-based infrared sensor.
2.1.2. Conflict	Conflicting or contradictory assignments or substitutions.	Two types of sensors (e.g., radars and infrared cameras) producing conflicting signatures of incoming objects.
2.1.3. Inaccuracy	Bias and distortion in degree.	Miscalibration of a sensor leading to inaccurate readings.
2.2. Incompleteness	Lacking or non-whole knowledge in its extent due to absence or uncertainty.	
2.2.1. Absence	Incompleteness in kind.	Whether or not an adversary possesses any nuclear weapons.
2.2.2. Unknowns	The difference between the becoming knowledge state and current knowledge state.	Whether or not an adversary exists.

Source for terms and definitions: Ayyub, 2001



Taxonomy: Uncertainty

Term	Definition	Examples
2.2.3. Uncertainty	Knowledge incompleteness due to inherent deficiencies with acquired knowledge.	
2.2.3.1. Ambiguity	The possibility of having multi-outcomes for processes or systems.	
a) Unspecificity	Outcomes or assignments that are incompletely defined.	The number of warheads that could penetrate a BMD system, where the types and characteristics of warheads and BMD are not stated.
b) Nonspecificity	Outcomes or assignments that are improperly or incorrectly defined.	The number of warheads that could penetrate a BMD system, where the numbers of rivets in the respective systems are stated.
2.2.3.2. Approximations	A process that involves the use of vague semantics in language, approximate reasoning, and dealing with complexity by emphasizing relevance.	
a) Vagueness	Non-crispness of belonging and non-belonging of elements to a set or a notion of interest.	The response to a U.S. strike in a crisis scenario (not otherwise specified).
b) Coarseness	Approximating a crisp set by subsets of an underlying partition of the set's universe that would bound the set of interest.	An estimate of the response to a U.S. strike in a crisis scenario, based on a list of plausible adversaries and scenarios, but not a specific adversary and detailed scenario.
c) Simplifications	Assumptions needed to make problems and solutions tractable.	An estimate of the response to a U.S. strike in a crisis scenario, based on two extreme cases, without considering a wide range of intermediate cases.
2.2.3.3. Likelihood	Defined by its components of randomness and sampling.	
a) Randomness	Non-predictability of outcomes.	The probability of zero penetrators under a given circumstance.
b) Sampling	Samples versus populations.	Estimating SSPK based on five tests.

Source for terms and definitions: Ayyub, 2001



The Role of Expert Opinion Elicitation

Expert-opinion elicitation is a formal process of obtaining information or answers to specific questions about particular quantities

- Quantities are called “issues”
- Issues may include probabilities or consequences of potential events
- Probabilities may relate to human decisions or to chance events

Expert-opinion elicitation is applied where data is inadequate

- Where significant uncertainty or incompleteness of data exists
- Where issues are controversial or contentious
- Where situations are highly complex
- Where uncertain or incomplete data has a significant effect on decisions and outcomes

The selection of experts is crucial to the usefulness of elicitation

- Strong relevant expertise is needed, *with a diversity of viewpoints*
- Familiarity with and knowledge of at least some aspects of the issues at hand
- Availability and willingness to act as proponents or impartial evaluators
- Strong communication skills, interpersonal skills, flexibility, impartiality, and ability to generalize and simplify

Source: Ayyub, 2001



Limitations of Expert Opinion Elicitation

Human judgment is fallible and variable

- Experts vary in problem definition, information, and problem-solving rules
- Experts vary in belief systems and cognitive styles

Experts are known to exhibit judgmental biases

- Confirmation bias: Disregarding information that contradicts one's prior beliefs
- Social pressure: Describing beliefs in a socially desirable way
- Actor-observer bias: Attributing one's own behavior to the situation while attributing others' behavior to their fundamental dispositions
- Overconfidence: Assigning unduly high levels of confidence to one's conclusions

Intuitive or "heuristic" judgments can produce misleading results

- Representativeness: Assuming that a single thing or event that *resembles* a class of things or events is *representative* of them
- Availability: Gauging probability of an event by how readily it comes to mind
- Affect: Gauging both the benefits and risks of a thing or event by one's general feeling about it, positive or negative
- Anchoring: Remaining close to an initial value when making estimates

Sources: Kahneman, Slovic, and Tversky, *Judgment under Uncertainty: Heuristics and Biases* (1982); Plous, *The Psychology of Judgment and Decision Making* (1993); Mumpower and Stewart, "Expert Judgement and Expert Disagreement," *Thinking and Reasoning* 2 (1996); Hammond, *Human Judgment and Social Policy* (1996); Finucane et al., "The Affect Heuristic in Judgments of Risks and Benefits," *J. of Behavioral Decision Making* 13 (2000); Tetlock, *Expert Political Judgment: How Good Is It? How Can We Know?* (2005).



Intuition and Bias in Strategic Security Affairs

Nuclear deterrence has yet to fail. The non-empirical nature of strategic debates allows subjective factors to play a large role in expert opinion.

Intuition and prior beliefs are strong, even dominant, forces

- Interviews show well-defined and enduring “camps” on nuclear forces and NMD
- Recurring findings suggest that key beliefs are *post hoc* rationalization of intuitions, even when they are in tension with analysis
 - Nuclear force matching is often justified by impression management, but experts differ on whose impressions are being managed
 - Jervis maintains that nuclear force matching depends on the difficulty of recognizing the revolutionary character of nuclear weapons and the inescapable reality of mutual vulnerability
 - Belief in the *advantageousness* and *feasibility* of NMD (or lack thereof) are correlated, despite being analytically distinct

Vivid metaphors, analogies, and images shape prior beliefs

- “Munich” and “Vietnam,” “dominoes” and “bandwagons” often dominate views of complex international situations
 - Possible examples of representativeness and availability heuristics
- “Rogue state” category is a possible example of actor-observer bias

Sources: Kull, *Minds at War* (1988); Kanwisher, “Cognitive Heuristics and American Security Policy,” *J. of Conflict Resolution* 33:4 (1989); Jervis, *The Meaning of the Nuclear Revolution* (1989); Vertzberger, *The World in Their Minds* (1990), Jervis & Snyder, eds. *Dominoes and Bandwagons* (1991), Herron et al., *Mass and Elite Views of Nuclear Security, Vol. II* (2000); Litwak, *Rogue States and U.S. Foreign Policy* (2000)



Addressing the Limitations of Expert Judgment

All the limitations of expert judgment cannot be overcome, but many of the known liabilities can be minimized by the selection process, preparations, and the method of elicitation itself.

Using multiple, diverse experts

- Use of multiple experts helps to address fallibility, overconfidence
- A diverse pool of experts helps to address variability
 - In the present context, “diversity” signifies both multiple types of expertise and representation from the different camps on strategic issues

Educating experts

- Creating awareness of biases and heuristics can help to debias experts’ responses

Seeking independent responses

- Asking experts to record responses silently without extensive prior discussion helps to address social pressure
- Given the complexity of the scenario, some discussion is necessary to eliminate ambiguity and clarify the meaning of issues



Appendix: Deterrence in Strategic Context

- Introduction
- Understanding the Issues
- Uncertainty and Expert Opinion
- Appendix: Deterrence in Strategic Context



Deterrence in Strategic Context

Deterrence can be understood as only one part of a larger set of antagonistic strategies. NMD can play roles within this wider arena.

Punitive or
Oppositional
Strategies in an
Adversarial Dyad

- How can the U.S. use strategic forces, including NMD, to influence outcomes?



Instrumental
Objectives

- What objectives do strategic forces (including NMD) pursue in order to support these strategies?



Concepts of
Operations
(CONOPS)

- How would strategic forces, including NMD, be employed to achieve these objectives?



Minimum
Operational
Requirements

- To support these CONOPS, how capable must strategic forces, including NMD, be?



Punitive or Oppositional Strategies

The broader context for NMD consists of punitive or oppositional strategies in an adversarial dyad. Both sides are assumed to have strategic offensive forces able to reach the other's homeland.

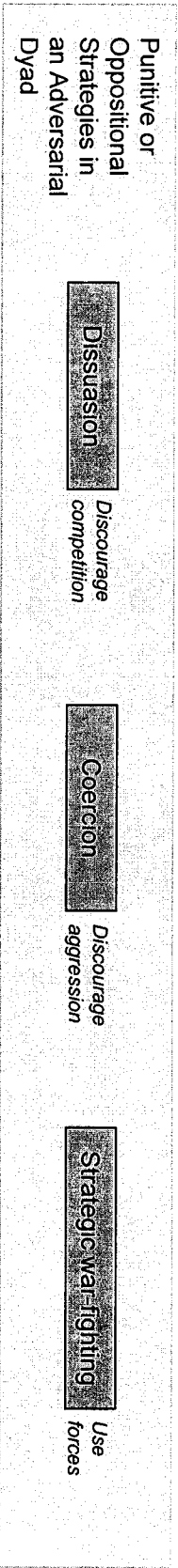
There are three major classes of such strategies

- Dissuasion
 - To discourage competition (e.g., arms racing) by making it seem futile
- Coercion
 - “[D]iplomacy based on the power to hurt”
 - Treated here as defensively oriented, designed to discourage aggression
- Strategic war-fighting
 - To limit damage to the homeland by using defensive or offensive strategic forces

Source: Schelling, *The Strategy of Conflict* (1963)

Dissuasion is not treated in depth

- Dissuasion lacks clearly identifiable operational characteristics, and is secondary to the immediate concerns embodied in coercion and war-fighting





Varieties of Coercive Strategies

Coercion is an umbrella term for a variety of strategies whose requirements differ and must be considered individually.

There are two varieties of coercion

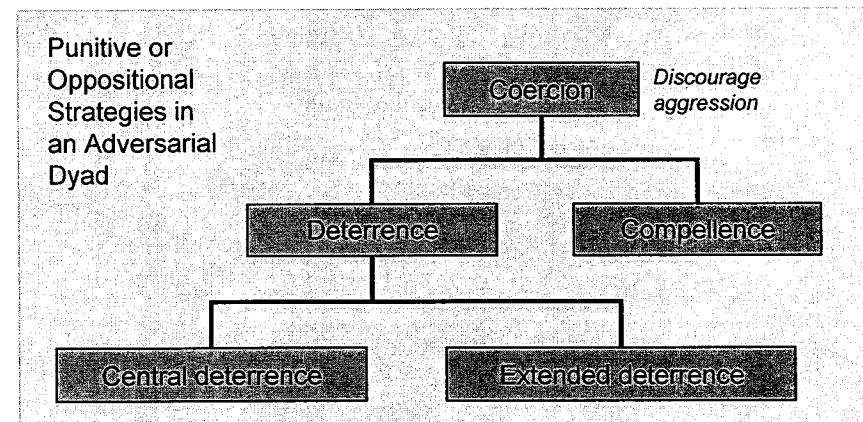
- Deterrence
 - Threats intended to keep an opponent from initiating an action
- Compellence
 - Threats intended to make an opponent initiate an action (e.g., reverse the results of aggression), or stop an action underway

Source: Schelling, *The Strategy of Conflict* (1963)

There are two main varieties of deterrence

- Central deterrence
 - Threats to discourage aggression against the homeland
- Extended deterrence
 - Threats to discourage aggression against national interests distinct from the homeland (e.g., allies and forward-deployed forces)

Source: Kahn, *Thinking About the Unthinkable* (1962)





Instrumental Objectives

Instrumental objectives describe in general terms what is required to support coercive or war-fighting strategies.

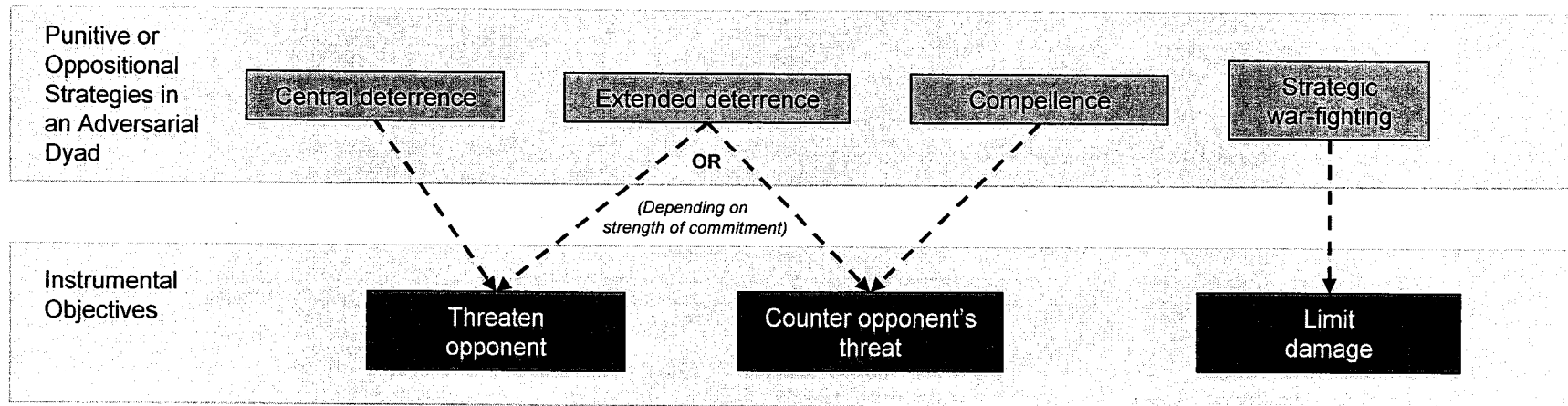
Central deterrence is supported by the ability to threaten an opponent

Compellence is supported by the ability to counter an opponent's threat

Strategic war-fighting is supported by the ability to limit damage

The requirements of extended deterrence are ambiguous

- When U.S. commitment is strong, the ability to threaten an opponent may suffice
- When U.S. commitment is less strong, the ability to counter the opponent's threat may be required





Concepts of Operations

Concepts of operations (CONOPS) describe how forces are to be employed to achieve objectives.

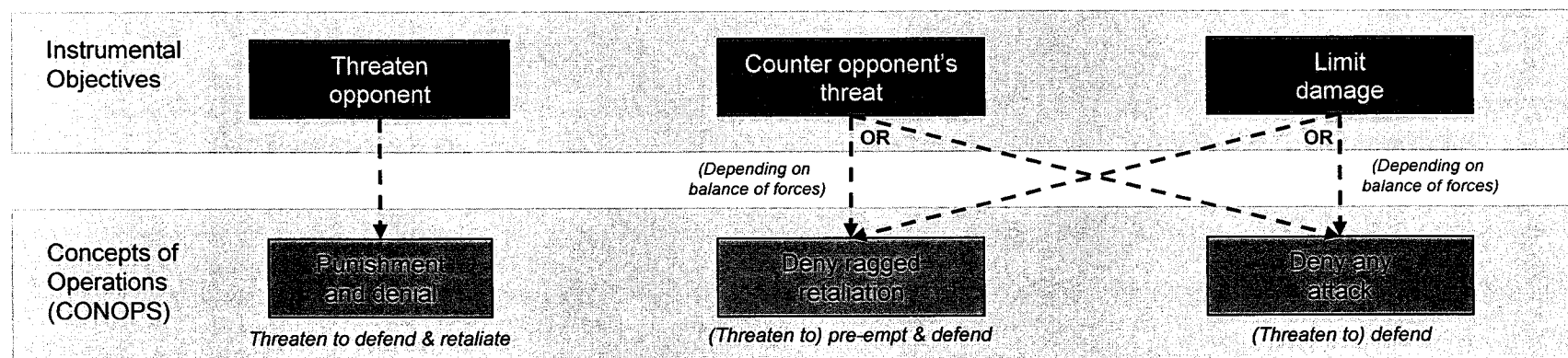
An opponent can be threatened by two means

- By threats of denial (*i.e.*, NMD) and punishment (*i.e.*, retaliation)

Source: G. Snyder, *Deterrence by Denial and Punishment* (1959)

How to counter a threat or limit damage depends on the balance of forces

- Against a less capable opponent, it may be possible to deny any attack
 - Countering an opponent's threat involves the credible threat to defend against any attack
 - Limiting damage requires actual ability and willingness to defend
- Against a highly capable opponent, it is necessary to deny ragged retaliation
 - Countering an opponent's threat involves the credible threat to preempt opponent's forces (counterforce attack) and defend against opponent's surviving forces
 - Limiting damage requires actual ability and willingness to preempt and defend





Minimum Operational Requirements

Minimum operational requirements support CONOPS.

Punishment and denial requires countervalue offense and limited defense

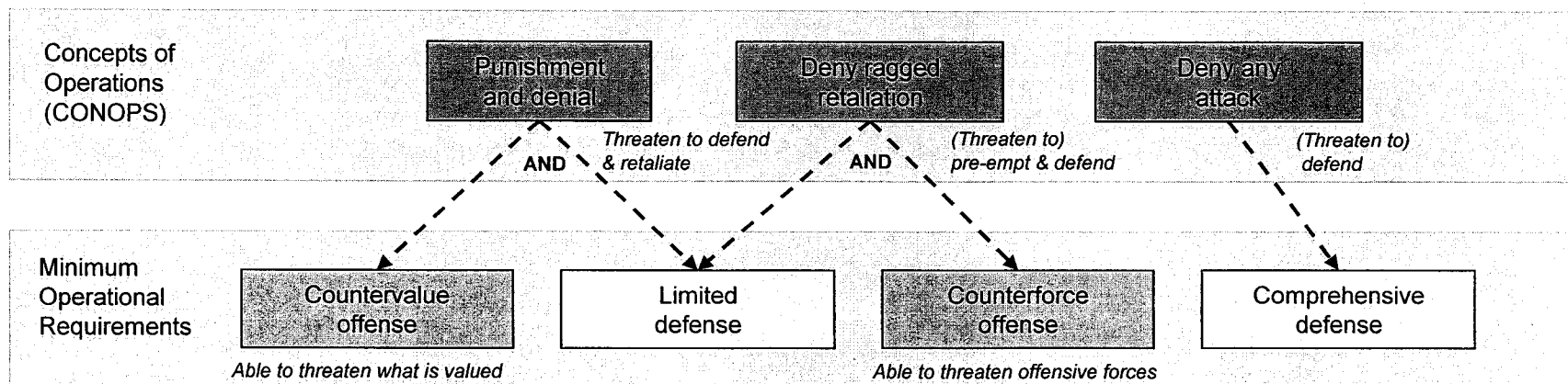
- Countervalue offense can threaten what an opponent values (e.g., cities, regime survival)
- A limited defense can stop a small-scale or less sophisticated attack

Denying ragged retaliation requires limited defense and counterforce offense

- Counterforce offense can threaten an opponent's offensive forces

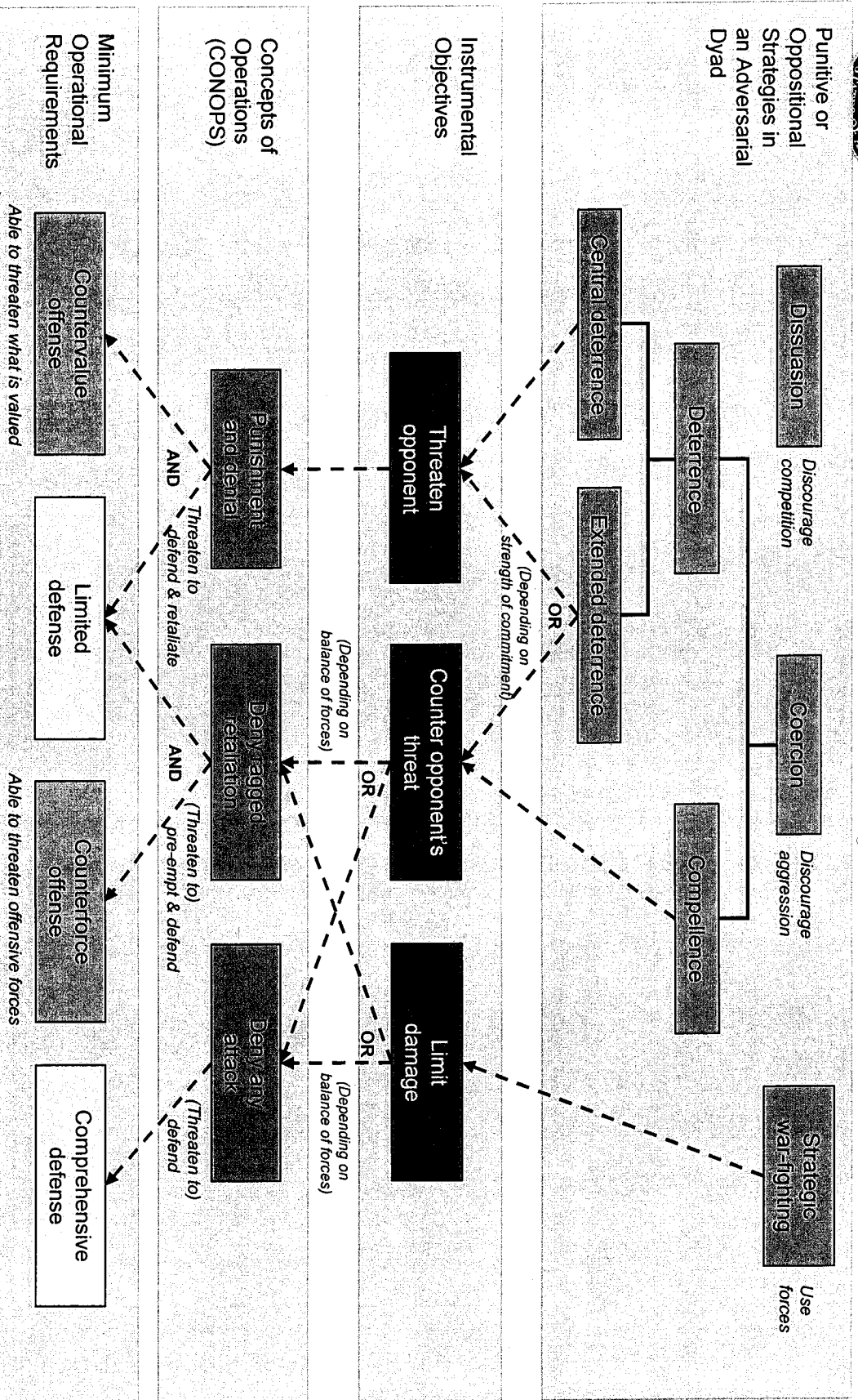
Denying any attack requires comprehensive defense

- Comprehensive defense can stop any attack that a given opponent can muster
 - This implies either a highly capable defense or a small-scale, less sophisticated opposing force





Summary of Typology





Basic Classes of Coercion and War-Fighting

The typology of punitive or oppositional strategies yields six basic classes of coercion and two basic classes of war-fighting.

	Coercion			Strategic war-fighting
	Central deterrence	Extended deterrence	Compellence	
Threaten opponent with punishment and denial	I	II (strong commitment)		
Nullify opponent's threat by denying any attack		III (less strong commitment, less capable opponent)	V (less capable opponent)	VII (less capable opponent)
Nullify opponent's threat by denying ragged retaliation		IV (less strong commitment, highly capable opponent)	VI (highly capable opponent)	VIII (highly capable opponent)



The Degrees of Immediacy

Coercive strategies occur with varying degrees of immediacy, *i.e.*, proximity to central war, characterized by strategic attacks against homeland targets.

Thresholds demarcate degrees of immediacy

- General deterrence occurs under the state of normal tension
- Immediate deterrence occurs under a state of crisis
- Intra-war deterrence occurs under a state of limited war
- Strategic war-fighting occurs under a state of central war

Compellence is inconsistent with the state of normal tension

- Defined as threats to make an opponent initiate an action, or stop an action underway

Deterrence and compellence are inconsistent with a state of central war

- Under these conditions, threats are being acted upon

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting



Deterrence in the State of Normal Tension

The state of normal tension involves general deterrence, a background condition to adversarial relations in the absence of a specific crisis.

General deterrence (central or extended) has three major characteristics

- The possibility of war between two sides
- The presence of strategic forces to deter war

Source: Morgan, *Deterrence: A Conceptual Analysis* (1977)

No more than preliminary consideration of war by either side, primarily because of strategic forces

- Example: Steady-state deterrence operations during the Cold War

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting



Deterrence in a State of Crisis

A state of crisis occurs when both sides recognize the possibility of war. Immediate deterrence prevents crisis from escalating to war.

Immediate deterrence (central or extended) has four major characteristics

- The possibility of war between two sides, with (at least) one side planning aggression
- The other side becomes aware of these plans
- The other side articulates a deterrent threat in response to this knowledge
- The side planning aggression decides to desist, primarily because of this threat

Source: Morgan, *Deterrence: A Conceptual Analysis* (1977)

Possible examples

- Berlin Crises of 1948-49, 1961, Taiwan Strait Crises of 1954-55, 1958

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting



Compellence in a State of Crisis

In a crisis, compellence is a threat to initiate war if one's terms are not met.

“Immediate compellence” can be characterized as follows:

- One side either controls or is in the process of acquiring an object (e.g., territory, technology) that another side deems important
- The other side threatens the use of force in an attempt to compel the first side to take some action (e.g., surrender the contested object)
- Leaders of the first side decide to take the action, primarily because of these threat(s)

The contested object is not necessarily territorial

- In the Cuban crisis of 1962, the contested object was missile deployments
- In the Iraq crisis of 1990-91, the contested object was the territory of Kuwait

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting



Deterrence in a State of Limited War

Intra-war deterrence limits the scope or scale of violence under limited war.

Intra-war deterrence (central or extended) has three major characteristics:

- War is underway between two sides capable of attacking each other's homeland with their respective strategic forces
- At least one side threatens strategic war-fighting to prevent escalation by geography, weapon types, target types, or objectives
- Officials on the other side exercise restraint, primarily because of these threat(s)

Sources:
 Brodie, Strategy in the Missile Age (1959);
 Schelling, The Strategy of Conflict (1963)

There are degrees of immediacy within limited war depending on the objectives at stake (*i.e.*, the nature of the contested object)

- *e.g.*, a territorial dispute vs. regime survival

Possible example

- Non-use of chemical or biological weapons in 1991 Iraq War

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting



Compellence in a State of Limited War

In limited war, compellence is a threat to escalate to central war if one's terms are not met.

“Intra-war compellence” can be characterized as follows:

- War is underway between sides capable of attacking each other's homeland with their respective strategic forces
- One side threatens strategic war-fighting to compel the other side to cease operations or to surrender the contested object
- Leaders of the other side decide to comply with the first side's demands, primarily because of the coercive threat(s)

As noted, there are degrees of immediacy within war depending on the objectives at stake (*i.e.*, the nature of the contested object)

- *e.g.*, a territorial dispute vs. regime survival

Example of attempt

- U.S. nuclear threats against China to motivate Korean War armistice talks

	Normal tension	Crisis	Limited war	Central war
Deterrence	General deterrence	Immediate deterrence	Intra-war deterrence	
Compellence		Immediate compellence	Intra-war compellence	
Strategic war-fighting				Strategic war-fighting