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The effectiveness of the U.S. missile defense capabilities as a deterrent to the North Korean missile threat

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THESIS

THE EFFECTIVENESS OF THE U.S. MISSILE DEFENSE CAPABILITIES AS A DETERRENT TO THE NORTH KOREAN MISSILE THREAT

by

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December 2007

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Over the last five years, America has placed an ever-increasing emphasis on missile defense and currently spends nearly $10 billion annually on its development. The United States' current missile Defense system is integrated; it depends on the cooperation of defensive elements aboard ships, on land, in the air and space. The objective is to provide a layered defense with multiple opportunities to destroy an incoming missile. By investing heavily in missile defense technology, the United States is clearly aiming to protect itself and its allies, but it is also attempting to deter its enemies and other terror regimes from spending their dollars on long-range missiles with the capabilities of hitting United States targets. The underlying theory is that rogue regimes possess limited funds and will not invest precious dollars on weapons that will not be effective during an attack. The United States believes its missile defense system is a deterrent to rogue states. However, North Korea's test launches in July 2006, along with subsequent testing of a nuclear device, illustrates that while the United States' missile defense system may protect America from attacks, it may not be an effective deterrent to North Korea's further missile development and future use in offensive action.

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ABSTRACT

Over the last five years, America has placed an ever-increasing emphasis on missile defense and currently spends nearly $10 billion annually on its development. The United States' current missile Defense system is integrated; it depends on the cooperation of defensive elements aboard ships, on land, in the air and space. The objective is to provide a layered defense with multiple opportunities to destroy an incoming missile. By investing heavily in missile defense technology, the United States is clearly aiming to protect itself and its allies, but it is also attempting to deter its enemies and other terror regimes from spending their dollars on long-range missiles with the capabilities of hitting United States targets. The underlying theory is that rogue regimes possess limited funds and will not invest precious dollars on weapons that will not be effective during an attack. The United States believes its missile defense system is a deterrent to rogue states. However, North Korea's test launches in July 2006, along with subsequent testing of a nuclear device, illustrates that while the United States' missile defense system may protect America from attacks, it may not be an effective deterrent to North Korea's further missile development and future use in offensive action.

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF ABBREVIATIONS AND ACRONYMS

AAMDC	Army Air and Missile Defense Command
ABM	Anti-Ballistic Missile
ARSTRAT	United States Army Forces Strategic Command
DMZ	Demilitarized Zone
DOD	Department of Defense
GMD	Ground-Based Missile Defense
GPALS	Global protection Against Limited Strikes
HEU	Highly Enriched Uranium
ICBM	Intercontinental Ballistic Missile
JTAMDO	Joint Theater Air and Missile Defense Organization
MDA	Missile Defense Agency
N.K.	North Korea
NORAD	North American Aerospace Defense Command
NORTHCOM	United States Northern Command
PAC	Patriot Advanced Capability
PACOM	United States Pacific Command
SEDP	System Engineering and Design Process
SMDC	United States Army Space and Missile Defense Command
THAAD	Terminal High Altitude Area Defense
U.S.	United States
WMD	Weapons of Mass Destruction

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I must first thank my Creator for divine guidance that has yet again pushed me toward another milestone in life.

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I. INTRODUCTION

A. BACKGROUND

Without a doubt, North Korea is a thorn in America's side and has been for decades. Korea's post-WWII division by the United States and the Soviet Union was never envisioned as a permanent fixture. However, South Korea's government, which was backed by the United States, and that of North Korea's, led by the Soviet Union, were polar opposites. The ensuing tension and instability quickly led to a civil war, most commonly referred to as the Korean War, and what seems to be a permanent division of the country with the South remaining an American ally and the North an adversary. The relationship between the two divided countries, however, has benefited from South Korea's adoption of the "sunshine policy" in 1998. Accordingly, the South adheres to three basic principles in regards to the North: provocations from the North are not tolerated; cooperation regarding politics and economics are considered separately; and the South has no plans for invasion.[1]

Since the Korean War's close, the United States has kept a watchful eye on Pyongyang. With the conclusion of the Cold War and collapse of the Soviet Union, North Korea has become one of the most reclusive, dictatorial societies in the world. By the late 1980s allegations against North Korea included threats against neighboring South Korea and Japan through kidnappings and border encroachment, as well as a disregard for international law and failure to adhere to treaties it signed.[2] In addition to its other transgressions, the 1990s heralded North Korea's expanded army and aggressive pursuit of advanced military weapons at the cost of their citizens' welfare and country's economic well-being.

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[1] U.S. Department of State, Background Note: North Korea, Bureau of East Asia and Pacific Affairs. [website]; April 2007; available from http://www.state.gov/r/pa/ei/bgn/2792.htm; Internet; accessed on 21 July 2007.

[2] The White House. [website]; available from http://www.whitehouse.gov/nsc/; Internet; accessed on 16 July 2007.

At the turn of the century, North Korea's increasing animosity towards the United States and everything for which it stands was evident.[3]

After 11 September 2001, America's tolerance for nation-states that fail to play by the rules of international law and justice has been pushed to the limit. To the United States, North Korea represents the epitome of a rogue state and its feeling of disdain for America is reciprocated. Moreover, President George W. Bush has refused to be complicit in maintaining the status quo between North Korea and the United States fostered by both the Reagan and Clinton administrations. In his 2002 State of the Union Address, President Bush clearly and unequivocally let the world know that North Korea, as a part of the "axis of evil", was an enemy of the United States. Further, "North Korea has become the world's principal purveyor of ballistic missiles and has tested increasingly capable missiles while developing its own weapons of mass destruction (WMD) arsenal", and the United States must be prepared to deal with them accordingly.

B. PROBLEM

During the early years of the Cold War era, the United States chose to defend itself against attacks through a reliance on air and naval operations and a substantial body of ground forces stationed on the peninsula, but did not deploy a missile defense, even though there was a consistent research and development effort. In 1972, the United States signed the Anti-Ballistic Missile (ABM) Treaty severely restricting the further development of defensive missile systems. With the end of the Cold War, and new nuclear threats from terrorists and countries such as North Korea and Iran, the United States withdrew from the ABM Treaty in 2001.

Over the last five years, America has placed an ever-increasing emphasis on missile defense and currently spends nearly $10 billion annually on its

[3] The White House. [website]; available from http://www.whitehouse.gov/nsc/; Internet; accessed on 16 July 2007.

development.[4] The United States' missile Defense system as currently envisioned is integrated; it depends on the cooperation of defensive elements aboard ships, on land, in the air and space. The objective is to provide a layered defense with multiple opportunities to destroy an incoming missile.[5] By investing heavily in missile defense technology, the United States is clearly aiming to protect itself and its allies, but it is also attempting to deter its enemies and other terror regimes from spending their dollars on long-range missiles with the capabilities of hitting United States targets. The underlying theory is that rogue regimes possess limited funds and will not invest precious dollars on weapons that will not be effective during an attack. The United States believes its missile defense system is a deterrent to rogue states. However, North Korea's test launches in July 2006, along with subsequent testing of a nuclear device, illustrates that while the United States' missile defense system may protect America from attacks, it may not be an effective deterrent.

North Korea has already shown that the United States missile defense system is not a deterrent to the development of missiles with varying range and capability levels. Over the weekend of 4 July 2006, North Korea successfully test fired six short and medium range missiles, respectively identified as Scud and Nodong missiles. All of them had the capabilities of reaching Japan, which the United States considers an ally, and the United States has permanent military bases located in the country. North Korea also fired the Taepodong-2, a long range missile with the capability of threatening the United States homeland. However, its test launch proved unsuccessful within moments of liftoff. North Korea, though, was not deterred by this failure and on 9 October 2006, claimed to have successfully performed an underground nuclear test, which to this date has not been refuted by other global powers, including the United States.

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[4] "The Taepondong Democrats," *Wall Street Journal*, 21 July 2006, [journal online]; available from http://www.opinionjournal.com/editorial/feature.html?id=110008687; Internet; accessed 15 October 2007.

[5] "Missile Defense Test," *Wall Street Journal*, 21 June 2006, [journal online]; available from http://www.opinionjournal.com/editorial/feature.html?id=110008544; Internet; accessed 15 October 2007.

The United States is aware that North Korea maintains an inventory of approximately 800 missiles, including 100-200 Nodongs and Taepodong-1s and an undisclosed number of Taepodong-2 missiles.[6] North Korea is also developing a land-based mobile missile with the capability of reaching all of Japan. Since 2003, when North Korea withdrew from the Nuclear Nonproliferation Treaty, the United States has held discussions with Pyongyang urging them to abandon their nuclear pursuits and to stop counterfeiting United States currency, among other issues. The two countries reached an impasse in 2005, and all talks were severed after the United States froze North Korean assets at a Chinese bank.[7] Discussions between the two countries resumed a year later after North Korea test fired its intercontinental ballistic missiles, and the United States presumably realized its hard-line policy towards North Korea had not produce the desired results.[8] The resulting six party negotiations led to a February 2007 agreement whereby North Korea would shut down and seal its known nuclear facilities in exchange for one million tons of oil. For almost six months, the United States waited for North Korea to hold up its end of the bargain. In July, North Korea informed the United States that their sole reactor had been turned off as agreed upon, which was verified by United Nations inspectors two days later.

Critics of the Six Party Talks argue that the United States has been too accommodating toward North Korea. They are, after-all, a rogue regime that has been a blip on America's radar for decades. The United States' missile defense system does not appear to be a deterrent to the North Korean nuclear missile development. While they have shut off their nuclear reactor, talks will resume

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[6] Missile Defense Test," *Wall Street Journal*, 21 June 2006, [journal online]; available from http://www.opinionjournal.com/editorial/feature.html?id=110008544; Internet; accessed 15 October 2007

[7] "N. Korea Shuts Reactor, Calls for End to Sanctions," The Associated Press, 15 July 2007, [website]; available from http://www.npr.org/templates/story/story.php?storyId=11989018; Internet; accessed on 29 July 2007.

[8] Mike Shuster, "North Korea Slows Pace of Nuclear Talks," NPR, 30 March 2007, [website]; available from http://www.npr.org/templates/story/story.php?storyId=9237343; Internet; accessed on 29 July 2007.

regarding the destruction of their nuclear warheads in return for additional economic and political incentives. Regardless, The United States is well aware that North Korea has a history of reneging on its promises since we have traveled down the disarmament path with them before. Hence, the question becomes whether the United States' missile defense system will deter North Korea from utilizing its missiles in offensive actions against the United States and its allies should North Korea withdraw from its recent agreement.

C. ASSUMPTIONS

To evaluate the effectiveness of the United States' Missile Defense Capabilities as a deterrent to the North Korean Missile Threat, several assumptions must be made and the tenuous "peace" shared by the United States and North Korea represents many which have been made on the part of America that are likewise reflected in this research undertaking. First, North Korea poses substantial threat to the United States Forces in Korea and the allies in the Pacific region. Second, North Korea was developing intercontinental ballistic missiles with the potential to reach the West Coast of the United States. Third, the United States sees an end to nuclear proliferation in rogue states as vital to its interests, while North Korea values its nuclear program as leverage to attain goods and services from other nation-states. Pyongyang pursues weapon technology, shows its products to the world, then agrees to dismantle – for a price; then the cycle is repeated with Pyongyang illustrating technological advances beyond expectation. Lastly, previous diplomatic and economic sanctions against North Korea have been tantamount to cleaning a large wound with alcohol and failing to protect it with a band-aid – North Korea felt the burn, began to heal, but is willing to risk re-injury by renewing its weapons program. As reflected by their actions, it may be that North Korea has performed a risk analysis and determined more might be gained from their nuclear pursuits, or the appearance thereof, than lost. Further, history has shown that the United States and other nation-states have repeatedly given humanitarian and economic aid to

North Korea in exchange for inspections of weapons facilities and promises to halt nuclear weapons productions. Likewise, history has also shown that North Korea reneges on agreements after receiving the bargained for benefit. Whether this is done as a tactical maneuver to renegotiate for better terms or as an attempt to gain the upper hand is unknown and need not be assumed. It does naturally follow, however, that even though North Korea has once again agreed to stand-down, America's distrust of North Korea continued adherence to agreed upon commitments must be assumed.

The final set of assumptions relate to the interactions between the United States and North Korea. Despite the United States' designation of North Korea as a rogue state, it will be assumed that they will make reasoned decisions with foreseeable outcomes that further their goals, even though those goals may not fall in line with the presumptions of the rest of the international community. Meanwhile, it will be assumed that the United States can be relied upon to make rational decisions regarding North Korea that follow internationally accepted norms. We must also assume that although North Korea boasts the fourth largest military force in the world, they do not desire to engage the United States in a ground war; if North Korea had such intentions, they would likely have utilized the troops situated at the demilitarized zone bordering North and South Korea and taken offensive action by now. Equally as resistant to commit forces in a ground combat is the United States. American troops readily available in the Pacific region have not been employed, or at the least, placed on alert for action. Rather, the United States recognizes that its leadership in the Global War on Terrorism has stretched the American troops thin, while the battle's casualties accumulated in its pursuit have weakened the commitment of the country's citizens. Consequently, both sides have made their respective evaluations, and neither desires to lay their cards out on the table in the form of a ground war.

D. THESIS

The impetus for this thesis is to determine whether the United States truly has the upper hand in its high stakes game with the North Korea. The relationship between the United States and North Korea is clearly acrimonious, but the ability to maintain a tenuous "peace" hinges on their respective risk calculations of the other's ability to effectively attack and/or defend. The United States' Missile Defense Capabilities will be limited to the PAC-3, THAAD, and Interceptor Missiles; while North Korea's will be comprised of the Nodong, Taepondong-1, and Taepodong-2 missiles. I will analyze the firepower, range, and readiness of the players' missile capabilities. Moreover, game theory will be employed to determine whether the United States has miscalculated a bet that could lead to nuclear disaster.

E. METHODOLOGY

The ensuing chapters will evaluate the current missile defense capabilities of the United States and North Korea through application of the Systems Engineering and Design Process (SEDP). System engineering ensures that the optimum system is developed as planned, operates as designed, and ultimately meets the identified goal of the organization, while balancing performance, cost, schedule and risk. Ultimately, this blueprint assesses whether the North Korean Missile Threat is a bluff or the real deal; and if it's real, can the United States truly defend itself or are we simply wearing a poker face?

Further analysis contains an analysis of the current missile defense situation on the Korean Peninsula by utilizing Game Theory. Game Theory, a branch of applied mathematics and economics, is the mathematical study of human interactions described by rules of play and alternative choices.[9]

[9] David Levine, "What is Game Theory," [website]; available from http://www.dklevine.com/general/whatis.htm; Internet; accessed 17 March 2007.

The formal modeling approach utilized in non-cooperative game theory replicates a social situation by specifying the options, incentives, and information of the players in an attempt to determine the actions each will make to maximize their returns. This will provide a clearer picture of the political situation in which North Korea and the United States have become embroiled.

Relevant to this thesis is also empirical literature. The work of Korean scholars will provide in-depth knowledge of the decision making process of the current regime in North Korea. American articles and federal government documents will be relied upon to ascertain the United States' deterrence policy. In addition, special attention will be given to the historical lessons of the United States' deterrence policy during the Cold War.

The effect of this assessment is intended to prevent the United States from underestimating the North Korean Missile Threat. All of the nation's superpowers would agree that the decision to go to war is not to be made lightly, but the decision not to engage in combat operations should undergo meticulously careful considerations as well.

II. NEEDS ANALYSIS

A. OVERVIEW OF THE SYSTEMS AND ENGINEERING DESIGN PROCESS

Decision-makers throughout the world realize the value of utilizing an identified methodology in the creation of designs/systems. The Systems Engineering and Design Process (SEDP) appears to be particularly conducive in addressing the large-scale, complex problem of the North Korean Peninsula confronting the United States Military. The SEDP's basic framework begins with problem and stakeholder identification and analysis, followed by brainstorming and analysis of solutions, and concluding with a final selection and implementation. When used correctly, the four phases of the SEDP ensure the created system solves the identified problem. Accordingly, a successful outcome hinges on the proper assessment of the problem an organization faces; if the problem is not defined correctly, the resulting system will almost always be a failure. Assuming, therefore, that the United States has correctly utilized the Design and Analysis, Decision Making, and Implementation phases of the SEDP, this analysis needs only to focus on the initial phase – Problem Definition – to determine whether the United States has wasted valuable time, expended human energy, and squandered billions of dollars creating a great solution for the wrong problem.

B. PROBLEM DEFINITION

The Problem Definition phase of the SEDP is usually initiated when the reality of a situation differs from how one party envisions it should be. In the case of the North Korean Missile threat, the United States realizes North Korea's nuclear weapon and intercontinental ballistic missile pursuits pose a danger to homeland security and Asian/Pacific allies. Further, the United States believes its safety from North Korean offensive action rests upon the dismantling of

Pyongyang's missile program. Even though the United States has pumped more than 15 billion dollars into its own missile defense system, it has failed to deter North Korea's pursuit of weapons of mass destruction. Additionally, the United States has continuously refrained from initiating military action, instead opting to take a more diplomatic approach. A recent example of American diplomacy occurred in response to North Korea's latest display of "war games"; the United States led the Six Party Talks that culminated in the 2007 agreement whereby North Korea agreed to shut down its nuclear reactors, both known and unknown, as well as dismantle its ballistic missile weapons program. In exchange for their cooperation, North Korea was promised humanitarian, economic, and energy assistance, in addition to the removal of their country from the United States' list of countries that sponsor terrorism.[10] To this date, all parties to the Six Party Talks have performed in accordance to its resolutions.

North Korea has made and broken promises regarding its weapons program for decades, and therefore, despite the agreement reached by the Six Party Talks, the United States has continued to fund the development of its missile defense system. These actions are fully in line with the SEDP, which suggests that the United States explore its identified need of extinguishing North Korea's weapons program by performing a Needs Analysis. The Needs Analysis process creates the effective needs statement from an early, primitive, identified need. The effective needs statement recognizes there may be multiple courses of actions available to resolve a given problem. The first step toward developing the effective needs statement is to perform a comprehensive study of the perceived threat.

C. THE NORTH KOREAN MISSILE THREAT

An unpredictable regime that refuses to conform to international standards of diplomacy, humanity, and military operations is more than enough reason for

[10] U.S. Department of State, [website] February 2007, available from http://www.state.gov/r/pa/prs/ps/2007/february/80479.htm accessed on 27 July 2007.

the United States to maintain a watchful eye on North Korea. In the fall of 2002, the United States confronted North Korea when satellites showed that they possessed what was possibly an underground nuclear weapons complex. Pyongyang admitted to having a secret nuclear program based on highly enriched uranium and expelled International Atomic Energy Agency officials, prohibiting them from further facility inspections.[11] Additional claims of ballistic missiles, some alleged to be intercontinental, with chemical and possibly biological and nuclear payloads has made the United States' outlook on Pyongyang change from one of guarded suspicion to one of probable threat. Moreover, public criticism by the United States and a move to cease all heavy oil shipments to North Korea effectively ended all pretense of civility between the two countries.[12]

Since 2002, the United States has not wavered in its resolve that North Korea cease its nuclear program. North Korea, however, accused the United States of planning a "preemptive nuclear attack" against it and has not only withdrawn from its moratorium on missile testing but also moved ahead with its weapons program at full speed.[13] Due to the communist country's isolation, Washington's intelligence is not clear on the exact status of North Korea's nuclear program or missile capabilities. The United States had long been aware of a program employing plutonium, which makes compact weapons but requires large, easily detected reactors, and witnessed an example of the progress North Korea has made in this area in October 2006 when its first nuclear device was

[11] Larry A. Niksch, North Korea's Nuclear Weapons Development and Diplomacy, Congressional Research Service Report for Congress RL33590, Updated 3 January 2007.

[12] David E. Sanger and William J. Broad, "U.S. Had doubts on North Korean Uranium Drive," The New York Times, 1March 2007. [Website], available from http://www.nytimes.com/2007/03/01/washington/01korea.html?_r=1&n=Top/News/World/Countries%20and%20Territories/North%20Korea&oref=slogin; Internet; accessed 15 October 2007.

[13] Larry A. Niksch, North Korea's Nuclear Weapons Development and Diplomacy, Congressional Research Service Report for Congress RL33590, Updated 3 January 2007.

tested by the rogue country.[14] As unsettling as this appears, coming on the heels of North Korea's ballistic missile tests of July 2006, the United States has yet another concern regarding Pyongyang's suspected highly enriched uranium program (HEU). In contrast to plutonium, uranium creates larger warheads but the technology for enriching uranium is smaller and therefore easier to hide.[15] While the United States initially believed the HEU program to be highly efficient, it has most recently relaxed its stance on how quickly North Korea could produce an atom bomb utilizing uranium. Once again, the lack of credible, precise intelligence on North Korea's weapons programs is illustrated, and the United States is provided with further reason to consider the reality of North Korea's threat. The following represents a best estimate of the missile capabilities and inventory of North Korea's Nodong, Taepodong I, and Taepodong II missiles.

1. North Korean Missile Systems

a. Nodong

The United States' reports of North Korea's development of a purported 1,000 to 1,300 kilometer-range missile called the Nodong began in the early 1990's.[16] This was of particular significance due to the proximity of North Korea to South Korea and Japan, which would be easy targets for the Nodong. The Nodong was the product of more than 20 years of experience gained by North Korea through their Scud missile design, development, and testing.[17]

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[14] David E. Sanger and William J. Broad, "U.S. Had doubts on North Korean Uranium Drive," The New York Times, 1March 2007. [Website], available from http://www.nytimes.com/2007/03/01/washington/01korea.html?_r=1&n=Top/News/World/Countries%20and%20Territories/North%20Korea&oref=slogin; Internet; accessed 15 October 2007.

[15] Ibid.

[16] David C. Wright and Timur Kadyshevb, "An Analysis of the North Korean Nodong Missile," Science and Global Security, April 1994 [journal online]; available from www.caep.cetin.net.cn/jk/pdf/4_2wright.pdf; Internet; accessed on 15 August 2007.

[17] Joseph A. Bermudez, "A History of Ballistic Missile Development in the DPRK, Occasional Paper No. 2," Monterey Institute of International Studies Center for Nonproliferation Studies, 1999, [website]; available from http://cns.miis.edu/pubs/opapers/op2/op2.pdf; Internet; accessed on August 19, 2007.

When North Korea's initial launch of the Nodong was only 500 kilometers across the Sea of Japan (heading toward Japan) in May 1993 a number of analysts speculated that the test was designed for the Nodong's evaluation by potential buyers.[18] Others viewed the test as a tactical show of defiance by the North Koreans in the face of pressure concerning their nuclear arms pursuits.

Since 1993, more has been discovered about the Nodong's actual capabilities. United States intelligence has shown that North Korea's current Nodong reached full deployment capability in the late 1990s. It has a single stage, liquid-fueled engine that can carry either a high explosive or chemical warhead payload of 800 – 1,000 kilograms with a range of approximately 1,300 kilometers.[19] Although North Korea has not demonstrated the capability to deliver nuclear weapons with the Nodong, this possibility must be carefully considered. Moreover, North Korea has reportedly deployed more than 100 of these medium range ballistic missiles to Iran and Pakistan, while maintaining its own inventory of an estimated 200 Nodong's, all of which are capable of targeting South Korea and most of Japan, where the United States maintains military bases.[20]

b. Taepodong I

The Taepodong I is a modified version of the Nodong missile and is often referred to as Nodong II. Very little was known about North Korea's Taepodong program until it launched the Taepodong I on 31 August 1998.[21] It is now believed that initial production for the missile began as early as 1997 with

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[18] David C. Wright and Timur Kadyshevb, "An Analysis of the North Korean Nodong Missile," Science and Global Security, April 1994 [journal online]; available from www.caep.cetin.net.cn/jk/pdf/4_2wright.pdf; Internet; accessed on 15 August 2007.

[19] Global Security, "Missiles – North Korea Special Weapons," [Website]; available from http://www.globalsecurity.org/wmd/world/dprk/missile.htm; Internet; accessed on 19 August 2007.

[20] Ibid.

[21] Steven A. Hildreth, North Korean Ballistic Missile Threat to the United States, Congressional Research Service Report for Congress: Order Code RS21473, updated 25 July 2007.

prototypes having been created approximately two years earlier. The missile utilizes a Nodong-type missile for its first stage, followed by North Korea's proven Scud missile technology for the second stage to achieve an estimated 2,000-kilometer range. The 1998 launch, surprisingly, included a third stage, believed to be an attempt to place a satellite into orbit, which failed, but did extend the range of the Taepodong I by 800 kilometers. After the launch, some analysts postulated that a properly functioning missile could attain a 3,800 – 5,900 kilometer range with a 700 – 1, 000 kilogram payload, able to reach Japan, Okinawa, and Guam.[22] As with the Nodong, the Taepodong I uses liquid fuel and has not been fitted with a nuclear payload, yet it appears possible. Moreover, while the Taepodong I is unable to reach the continental United States, this intermediate range ballistic missile is capable of striking the sites of major United States military bases. Intelligence analysts estimate North Korea to have produced no more than 10 Taepodong I missiles by the end of 1999, and no reliable source exits as to their current numbers.[23]

c. Taepodong II

Although the United States was aware the Taepodong II was in production as early as 2003, the missile had not been tested by North Korea until the recent July 2007 launches. North Korea hailed the test launch a success, while the United States deemed it a failure since the missile fell into the Sea of Japan of its own accord after a 40 second flight. Nevertheless, the United States estimates that an operational, two-stage Taepodong II with an estimated range of 6,700 kilometers could reach Alaska, Hawaii, and parts of the western continental United States, while delivering a 700 – 1,000 kilogram payload, and moreover, a three-stage Taepodong II could strike all of the United States with

[22] Larry A. Niksch, North Korea's Nuclear Weapons Development and Diplomacy, Congressional Research Service Report for Congress RL33590, Updated 3 January 2007.

[23] Steven A. Hildreth, North Korean Ballistic Missile Threat to the United States, Congressional Research Service Report for Congress: Order Code RS21473, updated 25 July 2007.

similar capabilities.[24] Given the failed launch, however, it is unlikely that North Korea would be able to deliver such payloads with any level of accuracy for several years to come.[25] The threat that the rogue nation could attempt such an offensive puts the United States at risk, especially since the launch indicates North Korea has made rapid technological strides with its Nodong missile, a derivative of which comprises the Taepodong II.[26]

D. STAKEHOLDERS ANALYSIS

The Stakeholders Analysis represents one of three primary tools utilized in the Needs Analysis to develop the effective needs statement. The Stakeholders Analysis identifies organizational players relevant to the problem and determines their needs, wants and desires, and responsibilities in its regard; it allows the organization to assess all parties that may provide assistance in solving their problem. While it is safe to assume that Americans in general desire to be secure from attacks by rogue nations, the United States Department of Defense DOD maintains overall responsibility for protecting American citizens and infrastructure from organized attacks. Its primary mission is to provide the military forces needed to deter war and protect the security of the United States, and in the furtherance of this goal DOD has charged several governmental agencies with the planning and implementation of its objectives.[27] The following represents the key stakeholders within the DOD and identifies their roles, interests, and priorities in maintaining a safe and secure United States.

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[24] Steven A. Hildreth, North Korean Ballistic Missile Threat to the United States, Congressional Research Service Report for Congress: Order Code RS21473, updated 25 July 2007

[25] Center for Nonproliferation Studies, Monterey Institute of International Studies, "Special Report on North Korean Ballistic Missile Capabilities," 22 March 2006 [website]; available from http://cns.miis.edu; Internet; accessed on 9 August 2007.

[26] Ibid.

[27] U. S. Department of Defense, [website]; available from www.defenselink.mil; Internet; accessed on 20 August 2007.

1. Agencies

a. NORTHCOM

United States Northern Command (NORTHCOM) was established in 2002 to provide command and control of DOD homeland defense efforts and to coordinate defense support of civil authorities.[28] NORTHCOM plans, organizes, and executes homeland defense operations to deter, prevent, and defeat threats and aggression from enemies. It must anticipate and protect the air, land, and sea approaches to the continental United States, Alaska, Canada, and Mexico.[29] Given that NORTHCOM maintains very few permanent military forces, it is assigned forces at the request of the President of the United States or Secretary of Defense as needed to execute missions.

b. NORAD

The North American Aerospace Defense Command (NORAD) is a cooperative organization between the United States and Canada responsible for North American aerospace warning and control. To accomplish the aerospace warning mission, NORAD monitors man-made objects via satellites to detect, validate, and present an Integrated Tactical Warning and Attack Assessment to both governments.[30] The satellites must be capable of distinguishing between a hostile aircraft, missile, or space vehicle. Aerospace control ensures air sovereignty through the defense of Canadian and United States airspace by utilizing air-based radar and fighters to detect, intercept, and, when necessary, engage any threat.

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[28] U.S. Northern Command, [website]; available from www.northcom.mil; Internet; accessed on 20 August 2007.

[29] Ibid.

[30] North American Aerospace Defense Command, [website]; available from www.norad.mil; Internet; accessed on 20 August 2007.

c. JTAMDO

Joint Theater Air and Missile Defense Organization (JTAMDO) is the management structure initiated by the DOD in 1997 to provide the joint forces commanders an improved capability to defend against air and missile threats. It is chartered to plan, coordinate, and oversee Joint Air and Missile Defense requirements, joint operational concepts, operational architectures, and development of the Joint Integrated Air and Missile Defense roadmap.[31] JTAMDO is responsible for evaluating systems and emerging technologies in order to determine air and missile defense capabilities and deficiencies, as well as to improve weapon system performance. Through analysis, simulations, and demonstrations, JTAMDO determines the optimum mix of surveillance, fire control, and battle management to counter aircraft, cruise missile, and ballistic missile threats.[32]

d. MDA

The Missile Defense Agency (MDA) has as its mission to develop, test and prepare an integrated ballistic missile defense system. The designed system, only part of which maintains a static location, provides a multi-layered defense for the United States, deployed forces, and allies against ballistic missiles of all ranges in all phases of flight.[33] To accomplish its goal, MDA employs complimentary land, sea, air, and space-based interceptors in its hit-to-kill technology.[34] Ultimately, MDA is committed to a kinetic kill-based technology for interception.

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[31] JOINT STAFF FY 2006/2007 Budget Estimates Research, Development, Test, and Evaluation (RDT &E), Defense –Wide Exhibit R-1, RDT&E Budget Item Justification, February 2005, [website], available from http://www.dtic.mil/descriptivesum/Y2006/TJS/0605126J.pdf; Internet; accessed on 10 September 2007.

[32] Ibid.

[33] Missile Defense Agency, [website]; available from www.mda.mil; Internet; accessed on 20 August 2007.

[34] Ibid.

e. SMDC/ARSTRAT

The United States Army Space and Missile Defense Command (SMDC) became SMDC/ARSTRAT when the United States Army Forces Strategic Command was created in 2003. With this change came greater responsibility, and SMDC/ARSTRAT has necessarily assumed new missions that include planning and integrating Army capabilities for Global Strike, Information Operations and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance.[35] However, its primary focus remains its role as the proponent for space and ground-based midcourse defense.[36]

f. PACOM

United States Pacific Command holds responsibility for promoting security and peaceful development in the Asia-Pacific region by deterring aggression, advancing regional security cooperation, responding to crisis, and when required, fighting to win.[37] In addition to fighting the Global War on Terrorism, other major focus areas of PACOM include working with allies to strengthen relationships and conditions for regional security and prosperity, as well as ensuring operational plans are current and realistic, utilizing plausible assumptions and executable operational phases that are militarily winnable.[38]

Support for PACOM is provided by the 94th Army Air and Missile Defense Command (94th AAMDC), which is located at Fort Shafter, Hawaii. The 94th AAMDC conducts Joint and Combined Theater Air and Missile Defense according to PACOM operational plans and contingency operations.[39] Moreover,

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[35] U.S. Army Space and Missile Defense Command, [website]; available from www.smdc.army.mil; Internet; accessed on 20 August 2007.

[36] Ibid.

[37] U.S. Pacific Command, [website]; available from www.pacom.mil; Internet; accessed on 20 August 2007.

[38] Ibid.

[39] Ibid.

the 94th AAMDC serves as the joint integrator, synchronizing Joint Theater Air and Missile Defense Operations among the four United States Armed Services.[40]

E. CONCLUSION

The challenge North Korea brings to the peace and security of the United States and its interests and allies on the North Korean Peninsula cannot be denied. Particularly, in the wake of September 11, 2001, The United States has made threat assessments across the board in an effort to maintain cognizance of terrorist organizations as well as rogue nations. On the military front, the DOD holds ultimate responsibility for anticipating, thwarting, and if necessary, defending attacks against the United States, and they have charged several governmental agencies as key stakeholders to assure success in this mission. North Korea's current agreement per the Six Party Talks has failed to diminish the very real threat North Korea's missile arsenal could constitute to the United States at home and abroad. Consequently, the focus on aerial surveillance, intelligence operations, fire control, and everything else that is missile defense illustrates Washington's distrust of North Korea and rogue nations like them.

In accordance with the SEDP's Needs Analysis, the United States' early, primitive identified need of dismantling North Korea's ballistic missile program has been thoroughly evaluated in light of the North Korean Missile Threat. The United States also looked at its agencies to determine their possible role and capabilities in protecting against incoming missiles. Consequently, an effective needs statement consisting of dismantling North Korea's program, but also deterring an offensive, and, if necessary, protecting our interests at home and abroad was developed. This statement identifies what is needed to solve the problem of the North Korean Missile Threat, and thereby keep the United States and its interests safe.

[40] U.S. Army Pacific Command, [website]; available from www.usarpac.army.mil/94AAMDC/index.htm; Internet; accessed on 10 September 2007.

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III. CURRENT MISSILE DEFENSE ANALYSIS AGAINST NORTH KOREAN MISSILE THREAT

The Needs Analysis in Chapter II rendered an effective needs statement as follows: To keep America safe from air attacks by North Korea, we must develop a system that will deter the development and/or use of ballistic missiles against the United States at home and its allies abroad, as well as ensuring the operational capabilities of the designed system to protect the same if it fails to act as a deterrent. In this chapter, the SEDP's Value System Analysis, which represents the final step of the process, will be utilized to determine whether the system designed by the United States meets its specified need. Clearly, the historic post-WWII system did not deter North Korea from their intercontinental ballistic missile (ICBM) pursuits as evidenced by their withdrawal from the NPT and the technological advances seen in their ballistic missiles during the 2007 test launches. Hence the deterrence issue, as previously stated in Chapter I, is whether or not the United States' system will deter the rogue country from once again reneging on its agreement to cease their weapons pursuits in a first step toward launching an attack against the United States. To be clear, though, the following analysis will not determine whether the current system will in fact obtain its objective (for the likelihood of this occurrence is accomplished in the next chapter), but is instead limited to the feasibility of the designed ballistic missile system to perform its desired function – whether the system is capable of deterring and protecting.

A. DETER THE NORTH KOREAN MISSILE THREAT

Since the close of the Cold War, North Korea, as an unpredictable adversary of the United States, has arguably been the closest country to attaining the technology required to develop an ICBM with capabilities of reaching United States targets. As discussed earlier, missile defense was largely ignored prior to the 1990's. For nearly forty years, except for attack warning and

attack assessment, the United States' defense against nuclear warheads launched by ballistic missiles or from space was nonexistent, and defenses against cruise missiles was rudimentary at best.[41] (Essentially, a cruise missile is a flying bomb because it has wings and uses a propulsion mechanism similar to an airplane.) Over the last decade, though, missile defense has become among the cornerstones for the modernization of today's military. Suffice it to state, the Ground-Based Missile Defense System we have today was in fact spurred by the North Korean Missile Threat. President Reagan's vision of deterrence against the Soviet Union Missile Threat was based on increased defensive systems and a reduced numbers of nuclear missiles, for missile defense was believed to be less expensive than ballistic missile proliferation and just as effective in protecting against the threat.[42] It was President Clinton, though, that made the first formal adjustment in presidential policy with an emphasis on deterring nuclear weapons, not fighting them.[43] The Clinton Administration recognized the need for missile defense and, accordingly, provided funding for research but the Administration of President George W. Bush has truly shepherded the transformation of what was formerly known as the Ballistic Missile Defense Program into its current configuration as the National Missile Defense System.[44]

Using the 11 September 2001, terror attacks as evidence of the changing threats faced by the United States, the Bush Administration pushed an agenda to alter America's approach to deterrence and arms control.[45] Accordingly, the

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[41] Frank L. Gertcher and William J. Weida, *Beyond Deterrence: The Political Economy of Nuclear Weapons* (Boulder: Westview Press, 1990). 105.

[42] Ibid. 133.

[43] Baker Spring, "Why the Administration's Stockpile Stewardship Will Harm the U.S. Nuclear Deterrent," 7 October 1999 [website]; available from http://www.heritage.org/Research/MissileDefense/BG1334.cfm; Internet; accessed on 8 November 2007.

[44] Amy F. Wolf, "Missile Defense, Arms Control, and Deterrence: A New Strategic Framework," Congressional Research Service Report for Congress, Order Code RS21057, 31 October 2001.

[45] Ibid.

national security policy shifted from one of deterrence based solely on the threat of nuclear retaliation to an increased emphasis on reducing the incentive for proliferation and use of ballistic missiles by deploying a formidable defense system as well. As for the inevitable strain that the boost in United States missile technology and proliferation has caused with former enemies, such as the Soviet Union and China, the Bush Administration has often asserted that, "missile defenses threaten no one, except those who would threaten the United States."[46] Consequently, the American defense system has continued to receive increases in funding, catapulting a decades old defense system into an integrated, multi-layered schematic.

B. PROTECT AGAINST A NORTH KOREAN OFFENSIVE

Initially, against an adversary firing many offensive missiles, it was not believed that the missile defense system needed to be perfect; it was thought that even an imperfect defense could raise enough doubt in an adversary's mind to discourage an attack.[47] With the end of the Cold War and the prospect of less predictable adversaries with far fewer missiles, the concept of a "quality defense" – a system capable of completely thwarting a limited attack – became much more attractive. In December 2002, the Department of Defense was ordered by President George W. Bush, to begin fielding a capability that will protect our homeland, deployed forces, and our friends and allies from ballistic missile attack.[48] Two years and billions of dollars later, the MDA revealed a missile defense system hailed as being both operational and technologically superior.

The single layered defense system is designed to address the three phases of a ballistic missile's trajectory: boost, midcourse, and terminal. Boost

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[46] Amy F. Wolf, "Missile Defense, Arms Control, and Deterrence: A New Strategic Framework," Congressional Research Service Report for Congress, Order Code RS21057, 31 October 2001.

[47] Ibid.

[48] Missile Defense Agency Link, [website]; available from http://www.mda.mil/mdalink/html/basics.html; Internet; accessed 25 October 2007.

phase is the portion of the missile's flight occurring immediately after launch. Acceleration occurs under power to lift the payload into near space and only lasts for 3-5 minutes.[49] This phase represents the most ideal time for the threatening missile to be intercepted. The missile is easiest to detect because it is still intact and emits a bright and hot exhaust. Moreover, intercept in the boost phase would allow any falling debris to land in the territory of the launching country, keeping America and its friends safe from ancillary damage. The midcourse phase is the longest in the missile's trajectory, lasting up to 20 minutes. It begins when the booster rocket separates from the missile payload, allowing the missile to coast unpowered through space on the path to its target.[50] The length of the phase allows multiple intercept attempts to be made, and any falling debris should burn off as it reenters the earth's atmosphere. The terminal phase is not only the last phase of the missile's flight, but also represents the last opportunity to destroy the incoming threat. It occurs when the missile's warhead, most likely equipped with a chemical or nuclear payload, reenters the earth's atmosphere and is propelled under the force of gravity to its target. Given that this phase lasts only 30 - 60 seconds, it is the least desirable time to intercept a missile, yet much attention has been afforded to this phase of intercept since it is the last line of defense.[51]

MDA recognized that a superior missile system must not only address the phases of an incoming missile's trajectory, but that it must also provide for its varying distance capabilities. Ballistic missiles are classified according to their range; short-range is from 150 – 800 Kilometers, medium-range is from 800 – 2,399 kilometers, intermediate-range is from 2,400 – 5,499 kilometers, and intercontinental-range is 5, 500 and greater.[52] In regards to the threat posed

[49] Missile Defense Agency Link, [website]; available from http://www.mda.mil/mdalink/html/basics.html; Internet; accessed 25 October 2007.

[50] Ibid.

[51] Ibid.

[52] Steven A. Hildreth, North Korean Ballistic Missile Threat to the United States, Congressional Research Service Report for Congress: Order Code RS21473, updated 3 January 2007.

from North Korean ballistic missiles, the Nodong is medium range, the Taepodong I is intermediate range, and the Taepodong II is an intercontinental range ballistic missile. Accordingly, the United States maintains different missile capabilities for a long-range, medium-, and short-range missile shield. The overall system designed by MDA meets the advanced technology of the ballistic missile's varying ranges, while giving consideration to the trajectory stage in which the intercept will occur. Further, the system is integrated, utilizing all branches of the armed forces as well as the expertise of several DOD agencies to survey the airspace, collect data, and transmit intelligence regarding suspicious military activities.

C. THE NATIONAL MISSILE DEFENSE SYSTEM

Ballistic missile defense is the detection, tracking, engagement, and destruction of ballistic missiles at some point in their trajectory before the warhead is detonated at its target.[53] Known as the National Missile Defense System, the current United States configuration first determines the range capability of the incoming missile and then launches a compatible, intercepting missile aimed at targeting the threat based on its phase of flight. The highly advanced system maintains components at sea, in the air and space, and on the ground to keep America safe from rogue countries with ballistic missiles. Ground-Based Interceptors, Patriot Advanced Capability-3 (PAC-3) and Terminal High Altitude Area Defense (THAAD) are three components of the integrated defense system; together, they form the basis of the United States' ground-based missile defense and represent the primary deterrent to and protection from the North Korean Missile Threat.

[53] Frank L. Gertcher and William J. Weida, Beyond *Deterrence: The Political Economy of Nuclear Weapons* (Boulder: Westview Press, 1990). 105.

1. Ground-Based Interceptors

The United States successfully carried out its seventh intercept using Ground-Based Interceptors on 28 September 2007. Interceptors are a component of Washington's long-range missile defense shield. The nine interceptors at Ft. Greely, Alaska and two at Vandenberg Air Force Base in California were installed by the MDA in 2004 for the express purpose of taking out intercontinental ballistic missiles fired from North Korea.[54]

The interceptors, which can be brought to alert status in an emergency but are not yet on 24 hour alert, use a three boost phase motor and is designed to intercept long-range missiles along their trajectory during the mid-course phase.[55] It also uses the groundbreaking hit-to-kill technology rather than the historic exploding warhead. Consequently, there is little room for error since the defending bullet must collide with the North Korean warhead to stop its deadly mission. As previously stated, however, the mid-course phase is the longest in the missile's trajectory and allows several opportunities for an intercept to occur. Despite its recent successful intercept, critics regard Ground-Based Interceptors as an unproven system, having knocked down only six of the last 10 targets in intercepts tests since October 1999.[56] Nevertheless, MDA's belief in the system's operational capabilities is illustrated by their plan to spend four billion

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[54] Mike McCarthy, "Missile Defense for Europe Faces Tech Challenges" 30 May 2007 [website]; available from http://www.kuwaittimes.net/read_news.php?newsid=MTgzNzE3MDQ3NA; Internet; accessed on 31 October 2007.

[55] Steven D. Smith, "Missile Defense Program Moves Forward," American Forces Press 11 January 2006 [website]; available from http://www.defenselink.mil/utility/printitem.aspx?print=http://www.defense link.mil/news/; Internet; accessed on 1 November 2007.

[56] Jim Wolf, "U. S. Carries Out Successful Missile Defense Test," 28 September 2007 [website]; available from http://www.reuters.com/articlePrint?articleID=USWBT00766220070928; Internet; accessed on 29 October 2007.

dollars developing ten, two-boost phase Interceptors (for short and medium-range threats) for installation in Poland to counter the anticipated Iranian threat.[57]

2. PAC-3

The hit-to-kill PAC-3 missile has been heralded as the world's most advanced, capable, and powerful terminal air defense missile. Its advanced technology warhead was the first to defeat incoming targets with direct body-to-body impact, a system which forms the basis of all modern missile defenses.[58] Further, no other missile system defeats all airspace threats – ballistic missiles, cruise missiles, and aircraft.[59] The PAC-3's long-range missile defense proved 100 percent accurate and successful in Operation Iraqi Freedom, providing deployed forces and valued assets with protection during the under-a-minute, final phase of both medium and long-range missile threats.

The PAC-3 builds on its PAC-2 predecessor's air and missile defense infrastructure by transforming the old system with Lockheed Martin's PAC-3 Missile Segment upgrade. The PAC-3 is a single design unit that fires its hit-to-kill missile from a mobile launcher station, which can carry 16 PAC-3 missiles. The PAC-3 missile uses a solid propellant rocket motor with altitude control and inertial guidance to navigate toward its target at an intercept point that is specified prior to launch by a computer in its ground-based, engagement control station.[60] Given that the PAC-3 interceptor kills the incoming missile during the terminal phase of its trajectory, accuracy is key. Consequently, the

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[57] Mike McCarthy, "Missile Defense for Europe Faces Tech Challenges" 30 May 2007 [website]; available from http://www.kuwaittimes.net/read_news.php?newsid=MTgzNzE3MDQ3NA; Internet; accessed on 31 October 2007.

[58] Staff Writers, "PAC-3 Missile Destroys Tactical Ballistic Missile in Test," [website]; available from http://www.spacewar.com/reports/PAC_3_Missile_Destroys_Tactical_Ballistic_Missile_In_Test; Internet; accessed on 27 October 2007.

[59] Ibid.

[60] Lockheed Martin, [website]; available from http://lockheedmartin.com/products/PAC-3/index.html; Internet; accessed on 29 October 2007.

target's projected path can be updated to the kill vehicle during its flight by a radio frequency uplink/downlink.[61] Further advances in the PAC-3's technology are illustrated by the missiles on board radar that acquires the target and selects the optimal aim point to initiate terminal guidance shortly before arrival at the intercept point.[62]

The exact number of PAC-3 missile systems has not been released, but initial production allowed for the upgrading of three launchers per Patriot Battery, making their number total 16 (which is almost ½ of all Army Patriot launcher stations).[63] The Army recently awarded a contract worth more than $375 million dollars to Lockheed Martin for the production of 112 PAC-3 missiles, including launcher upgrade equipment and software.[64] This new contract comes on the heels of Lockheed Martin's delivery of the 500th PAC-3 missile to the Army.

3. THAAD

THAAD represents the link between Ground-Based Interceptors and PAC-3 missile systems. It is designed to intercept short-, medium-, and intermediate-range ballistic missiles that could threaten the United States, allies, and deployed forces.[65] Keeping in line with the vision of a multi-layered missile defense, THAAD missiles intercept at a higher altitude than PAC-3 within the terminal phase of an incoming missile's trajectory, as well as possessing the capability to intercept in the latter portion of the midcourse phase, which is the domain of

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[61] Lockheed Martin, [website]; available from http://lockheedmartin.com/products/PAC-3/index.html; Internet; accessed on 29 October 2007.

[62] Ibid.

[63] Paul G. Kaminski, Statement before the Military Research and Development Subcommittee of the House Committee on National Security on Ballistic Missile Defense on 6 March 1997.

[64] Staff Writers, "PAC-3 Missile Destroys Tactical Ballistic Missile in Test," [website]; available from http://www.spacewar.com/reports/PAC_3_Missile_Destroys_Tactical_Ballistic_Missile_In_Test; Internet; accessed on 27 October 2007.

[65] Robert P. Lenox, "Air and Missile Defense Goes Global," [website]; available from http://findarticles.com/p/articles/mi_qa3723/is_200612/ai_n17192966/print, Internet; accessed on 29 October 2007.

Ground-Based Interceptors. Additionally, the THAAD components are mobile; the launcher is truck mounted, and the radar is the largest, air-transportable one of its kind in the world.[66] THAAD also collides with missiles to destroy them, using the advanced hit-to-kill technology common to the aforementioned systems, as well as the PAC-3's on board missile technology to complete its missile defense capability.

THAAD entered the prototype manufacturing phase of production in 2000 and flight testing began in 2005. At the time of North Korea's test launch in July 2007, the THAAD system had failed to intercept its target in a test in May 2006. In January 2007, however, THAAD underwent another missile intercept test that was a success, and with only a 50/50 record, the United States once again displayed faith in its missile defense system and awarded Lockheed Martin a $619 million dollar contract for the production of the first two THAAD systems, which includes launchers, radars, intercept missiles, and operation centers.[67] Since then, THAAD successfully intercepted another target in April 2007, and the Army released that it expects to acquire 80 to 99 THAAD launchers, 18 ground-based radars and a total of 1,422 THAAD missiles.[68]

D. CONCLUSION

The question of whether or not the missile defense system designed by the United States to neutralize the North Korean Missile Threat actually performs as planned is determined by the Value System Analysis of the SEDP. A comprehensive study of the situation on the peninsula was performed and the Needs Analysis identified what the United States should do. Consequently, a rudimentary missile defense was catapulted into a state of the art, highly

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[66] Missile Defense Agency Fact Sheet, [website]; available from http://www.mda.mil/mdalink/html/factsheet.html; Internet; accessed on 25 October 2007.

[67] Technology News Daily, [website]; available from http://www.technologynewsdaily.com/node/5597; Internet; accessed on 12 November 2007.

[68] Missile Defense Agency Fact Sheet, [website]; available from http://www.mda.mil/mdalink/html/factsheet.html; Internet; accessed on 25 October 2007.

advanced system designed to deter attacks by rogue countries with ballistic missiles and to protect the United States, its allies, deployed forces, and valued assets throughout the world from the same threat.

The policy of deterrence is in itself a risk calculation, and the job of protection is about the perception of capability; the United States has spent billions of dollars playing a high stakes game. The high cost of the National Missile Defense System's ground-based components did not convince North Korea that their resources would be wasted on the proliferation of ballistic missiles. Yet, Pyongyang's willingness to stand-down and dismantle its weapons program may be an acknowledgement of the operational capabilities of the United States' Ground-based Interceptors, PAC-3, and THAAD. Further, now that all three systems have proven successful in test intercepts, and the PAC-3 has also proved to be 100 percent effective in battle, the Value System Analysis indicates that the designed system is capable of deterring North Korea from breaking promises made during the Six Party Talks to reinstitute their weapons program in order to launch offensive action against the United States. Moreover, Value System Analysis illustrates that the ground-based component of the NMD System is fully capable of protecting against a North Korean ballistic missile if the rogue country is foolish enough to launch an attack it is unlikely to complete.

IV. MODELING ANALYSIS

The Value System Analysis illustrates that the missile defense system designed by the United States is capable of deterring North Korea from reneging on promises made in the Six Party Talks by resuming their weapons program and launching an attack. The analysis further demonstrated that if North Korea failed to be deterred, the Ground-Based Interceptors, PAC-3, and THAAD all possess the capability of defending the United States and its allies abroad. As stated previously, North Korea has begun dismantling its nuclear facilities but has reneged on similar agreements in the past. Consequently, the United States has elected to continue development of its layered missile defense capability in order to detect, engage, and destroy long-range ballistic missiles despite the agreement reached in the Six Party Talks in an effort to defuse the threat on the North Korean Peninsula. There is, however, another analysis to be performed; in this chapter Game Theory will be utilized to determine if the U.S. truly has the upper hand in this high stakes game of ballistic missiles.

A. DEFINING THE GAME

Game theory is a branch of applied mathematics and provides a formal modeling approach to social situations in which decision makers interact with opposing agents, choosing strategies to maximize their return while taking into consideration the opposition's strategies as well.[69] The game will be played simultaneously, employing a competitive strategy for each player with no opportunities for the United States and North Korea to cooperate. The gaming matrix will be formulated, as modeled in Philip Straffin's Game Theory and Strategy, as a non-zero sum, two-person game, and moreover, the matrix will

[69] Philip D. Straffin, *Game Theory and Strategy*. (Washington D.C.: The Mathematical Association of America, 1993), 3.

result in a Prisoner's Dilemma.[70] A non-zero-sum game is one in which the sum of the payoffs for the two players under any strategy combination is greater or less than zero; that is a win by one player does not necessarily equate to a loss by the other.[71] Thus, Game Theory provides a basis for both North Korea and the United States to decide what strategy to utilize because it predicts the outcome of the political situation on the Peninsula based on the course of action each party takes.

B. QUESTION TO BE ANALYZED

As the United States continues to develop a robust missile defense capability to protect valued assets and interests at home and abroad, will the system, in fact, deter North Korea from breaking their promise to cease the proliferation of ballistic missiles (with a chemical or nuclear warhead)?

C. THE PLAYERS

North Korea is not known for its trustworthiness; the rogue country has historically gone against the grain of international conduct, then entered into an agreement to reform its behavior in exchange for economic benefit, only to later renege on the agreement and reenter negotiations for additional gain. North Korea determines what makes a country tick – in this case, ballistic missiles – and forges ahead with antagonizing behavior. Given this scenario, Pyongyang knows its ballistic missile pursuits are a cause of serious concern for the United States and has benefited once again, via the Six Party Talks, from its 2006 public display of missile technology. After calculating the risks, North Korea must decide whether to abide by its agreement to accept aid and cease further weapons of mass destruction proliferation, or simulate cooperation in order to

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[70] Philip D. Straffin, *Game Theory and Strategy*. (Washington D.C.: The Mathematical Association of America, 1993), 65-67.

[71] Daniel H. Wagner, W. Charles Mylander, and Thomas J. Sanders. Naval Operations Analysis. Naval Institute Press. 1999, 47.

attain additional economic and humanitarian aid at a later date, during another round of negotiations, or perform the unthinkable by launching an attack.

The United States can continue rapid development and heavy funding of its layered missile defense capability in order to detect, engage, and destroy long-range ballistic missiles. By doing this in spite of the agreement reached with North Korea in the Six Party Talks, the United States is operating under the assumption that history will repeat itself, and North Korea will renege. It naturally follows that if the rogue country reneges, the United States must ensure that its missile defense capability is credible enough to dissuade North Korea from attempting offensive action. However, the United States may also assume that a fully operational missile defense system, such as the one it developed, may act as a deterrent to North Korea's weapons pursuits because it would be an exercise in futility, not to mention a grand expenditure that the country would be better investing elsewhere.

D. PLAYERS' STRATEGIES

The following Strategy Matrix depicts the rankings given to both players' respective strategies based on their intersecting outcomes. The matrix has been assigned a scale of 1 to 4, with 4 being the most preferred strategy a player would select and 1 being the least preferred strategy. Again, neither player is afforded the benefit of knowing the strategy employed by the other player because both play at the same time. As illustrated below in Figure 1, each player therefore selects the best strategy to achieve their objective.

		N.K.	
		C - DIPLOMACY	D - MISSILE PROLIFERATION
U.S.	A - MISSILE DEFENSE	**AC (4,1)**	**AD (2,2)**
	B - DIPLOMACY	**BC (3,3)**	**BD (1,4)**

Figure 1. Strategic Choice Matrix

1. Player I – United States' Strategies

a. An integrated, layered missile defense system. The design allows air, sea, and land based defense systems to intercept threats in every phase of the incoming missile's trajectory, therefore providing a mobile and global security system. Moreover, the operational capability of the National Missile Defense System could undermine North Korea's confidence and, therefore, its willingness to attempt to impose widespread destruction on the United States and its allies by means of missile delivery.[72] The United States can benefit from continuing to develop, test, and improve its missile defense system.

b. Diplomacy. Current U.S. policy involves utilizing diplomatic means to maintain a stable military environment on the Peninsula while solving the problem of a North Korea with ballistic missiles and nuclear weapons.[73] The imposition of sanctions and a willingness to work with the rogue country to provide aid in exchange for their agreement to cease and desist has been the hallmark of the United States' diplomatic relations with North Korea. Further, the United States and its ally South Korea continue to maintain strong defenses along the demilitarized zone (DMZ); periodic military exercises elicit complaints

[72] Baker Spring, "A Comprehensive Set of Military Options for Countering North Korea's Growing Missile Threat", 5 July 206, [website], available from www.heritage.org/research/missilefense/wm1144.cfm; Internet; accessed on 25 October 2007.

[73] Edward F. Bruner, North Korean Crisis: Possible Military Options, Congressional Research Service Report for Congress: Order Code RS21582, updated 29 July 2003.

from North Korean officials, but they generally seem accustomed to and accepting of the existing military situation.[74]

2. Player II – North Korea's Strategies

a. Engage in diplomacy. North Korea would benefit from engaging in negotiations and adhering to diplomatic solutions with the U.S. and other members of the Six Party Talks. North Korea would receive a substantial humanitarian and economic aid package in addition to the removal of sanctions against the rogue country. Further, diplomacy could be the first step toward a more favorable view of the country by the international community.

b. Develop and test long-range ballistic missiles despite agreements to the contrary. North Korea hailed their missile tests of 2007 as a success, while Washington deemed the Taepodong II, at least, a failure. As stated earlier, though, some United States analysts believe the tests were not designed to showcase the missiles' full capability but instead to provide potential buyers with a limited demonstration. If this is true, North Korea could accept the benefit from the Six Party Talks while covertly continuing its weapons program to sell it to others, threaten the United States and its allies, and/or renegotiate for better terms in the future.

3. Value Assessment of Combined Strategies

AC – The United States enhances the current missile defense capabilities through its continued development and testing; North Korea engages in, and adheres to, diplomatic agreements to gain humanitarian and economic assistance. In this scenario, the United States is giving up nothing and, therefore, is assigned the greatest payoff of 4. In direct contrast, North Korea is giving up everything and, therefore, is assigned the lowest payoff of 1.

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[74] Edward F. Bruner, North Korean Crisis: Possible Military Options, Congressional Research Service Report for Congress: Order Code RS21582, updated 29 July 2003.

AD – The United States enhances the current missile defense capabilities through its continued development and testing; North Korea accepts the benefit of the Six Party Talks, but secretly continues to develop and test ballistic missiles. Consequently, the United States and North Korea are both assigned a lower payoff of 2; the benefit to the United States is offset by the aid given to North Korea when it has not given up its weapons pursuits, and likewise, North Korea's benefit is hindered by their clandestine agenda.

BC – The United States continues to utilize diplomatic measures to maintain the status quo on the North Korean Peninsula and prevents the further proliferation of ballistic missiles by the rogue country; North Korea engages in, and adheres to, diplomatic agreements to gain humanitarian and economic assistance. Consequently, the United States and North Korea are assigned a higher payoff of 3 because both countries are giving up something to receive a benefit.

BD – The United States continues to utilize diplomatic measures to maintain the status quo on the North Korean Peninsula and prevent the further proliferation of ballistic missiles by the rogue country; North Korea accepts the benefit of the Six Party Talks, but secretly continues to develop and test ballistic missiles. In this scenario, the United States is giving up something while receiving nothing in return, and is therefore assigned the lowest payoff of 1. In direct contrast, North Korea is giving up nothing while receiving a benefit and is therefore assigned the greatest payoff of 4.

4. United State's Supplementary Strategies

It is important to emphasize that strategies "BC" and "BD" do not imply a complete lack of missile defense by the United States. As discussed in Chapter 3, Washington has already developed an operational ground-based capability in the Interceptors, PAC-3, and THAAD. Further, the United States maintains active PAC-3 missile batteries in South Korea and Japan, and THAAD units are being developed and trained at Fort Bliss, Texas.

E. THE PRISONER'S DILEMMA GAME

Based on the assumptions and the strategies depicted for each of the two players, the game begins as depicted in the payoff matrix presented below in Figure 2. As stated, both countries' payoffs have been given independently to one another with 4 being the best and 1 being the worst. Drawing on the Principle of Rationality, which emphasizes that every player wishes to come out as well off as possible, it is further assumed that each player will make decisions based solely on his or her payoffs.[75]

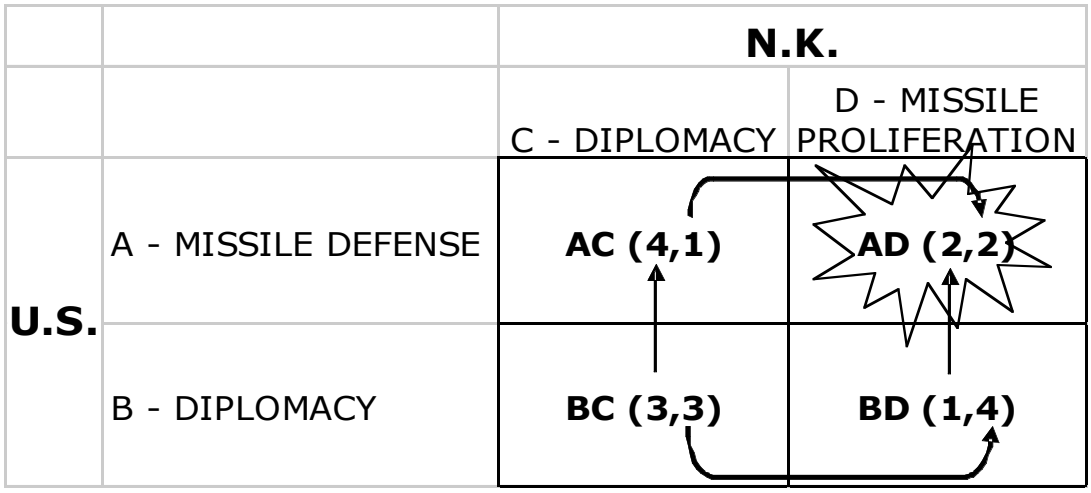

Figure 2. Illustration of Prisoner's Dilemma

Figure 2 also illustrates the North Korean Missile Threat as a Prisoner's Dilemma. A Prisoner's Dilemma is a type of non-zero-sum game in which two players may each "cooperate" with or "defect" (i.e. betray) the other player, while putting their own interests first. In the game's classic form, cooperating is dominated by defecting, making the only possible equilibrium in the game occur when all players defect.[76] In other words, no matter what the other player does,

[75] Saul Stahl, *A Gentle Introduction to Game Theory*, American Mathematical Society, 1999 v. 13.

[76] Saul Stahl, *A Gentle Introduction to Game Theory*, American Mathematical Society, 1999 v. 13.

one player will always gain a greater payoff by playing defect. Given that playing "defect" is always more beneficial than cooperating, all rational players will play "defect". The unique equilibrium for Prisoner's Dilemma is referred to as a Pareto-suboptimal solution, meaning that rational choice leads the two players to both play defect even though each player's individual reward would be greater if they both played cooperate, hence the dilemma.[77]

Furthermore, as a result of the expected payoffs illustrated in Figure 2, a Nash Equilibrium exists, indicating that neither player can freely improve their position unilaterally. This is depicted with the implementation of Strategies A and D, where the United States enhances the current missile defense capabilities through its continued development and testing, while North Korea accepts the benefit of the Six Party Talks, but secretly continues to develop and test ballistic missiles (2,2). Of note, though, is that this strategy of attack, where each player elects their most desired strategy, does not ensure that a higher payoff score is obtained.

1. Strategic Move Defined

Although North Korea and the United States will want to play defect to attain the best benefit, their respective moves are not random but instead represent a strategic move. A strategic move is designed to alter the beliefs and actions of others to attain a higher payoff.[78] The distinguishing feature from this move and a random one is that the strategic move purposefully limits a player's freedom of action because of its innate subterfuge.[79]

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[77] Saul Stahl, *A Gentle Introduction to Game Theory*, American Mathematical Society, 1999 v. 13.

[78] Avinash K. Dixit and Barry J. Nalebuff, *Thinking Strategically; The Competitive Edge in Business, Politics, and Everyday Life.* New York, London: W.W. Norton & Company, 1991.

[79] Ibid.

2. Conducting a Strategic Move

For North Korea to improve their payoff from the Nash Equilibrium of 2,2 that is likely to occur without communication, they would need to promise the United States of their intention to abide by the Six Party Talks since it is in the best interest of both parties. If North Korea is successful, both parties will move to the higher payoff of 3,3. However, if North Korea promised to continue engaging in diplomatic relations, then covertly continued to develop and test ballistic missiles, neither country would maintain the higher payoff of 3,3; a 1,4 payoff in N.K. favor would then occur.

For the United States to improve their payoff from the Nash Equilibrium of 2,2 that is likely to occur without communication, they would need to promise North Korea that the current security measures are not a threat to them, and the adherence to the diplomatic solution agreed upon in the Six Party Talks will maintain the status quo, which is in the best interest of both countries. If successful, the United States will improve their payoff to a 3,3. However, if the United States promised to maintain the status quo, then covertly began developing new, more advanced technology for its missile defense program, neither country would maintain the higher payoff of 3,3; a 4,1 payoff in favor of the United States would then occur.

For further illustrations of the players' strategic moves with an in-depth analysis see APPENDIX B. In addition, the players' Security Values are depicted in APPENDIX C.

F. CONCLUSION

In reality, North Korea has much more to gain by reneging on its agreement then by keeping its word. The United States has continued to utilize diplomacy when dealing with the rogue country rather than escalating the stakes with military action. History continues to repeat itself until one party tires of the cycle. The country that keeps giving – humanitarian aid, economic incentives,

and crude oil – is the United States, while North Korea keeps receiving. The United States' missile defense system, as capable as it is, has very little likelihood of deterring the rogue country from reneging on the agreements made in the Six Party Talks. It will, however, deter them from launching a missile against the United States and its allies because the rogue country knows that the operational capabilities of the Ground-Based Interceptors, PAC-3, and THAAD will prevent completion. Whether it happens next year or ten years from now, North Korea will once again show its ballistic missile and nuclear weapon hand. North Korea stands to gain more by forcing additional diplomatic concessions, than adhering to their word.

V. CONCLUSION

The game of ballistic missiles is truly high stakes; a miscalculation of the value of your cards or an unsuccessful bluff equals mass destruction. The United States believes it has the upper hand. More than $10 billion dollars a year is currently being spent to defuse the threat on the Peninsula caused by North Korea. The layered defense system developed by the United States was designed to meet the SEDP's effective needs statement of dismantling North Korea's weapons program, but also deterring an offensive, and, if necessary, protecting our interests at home and abroad. Consequently, the United States' policy of diplomacy toward North Korea is shrouded in deterrence.

The aim of the National Missile Defense Program is first to deter and second to protect. The United States believes that by having a heavily funded, technologically advanced, and fully operational missile defense system in place, rogue countries like North Korea will think twice about spending their limited resources on ballistic missile and nuclear weapon proliferation. However, in this respect the system has failed, for North Korea has not been deterred in its development of weapons of mass destruction. Instead it has used its missile proliferation to acquire resources from the United States and other countries; the Six Party Talks of 2007 outline the most recent agreement. Thus, the question becomes whether North Korea will be deterred from following its historic pattern of breaking promises to cease its weapons pursuits.

The SEDP's Value System Analysis determines if the United States' missile defense system is capable of performing its designed function – to deter and to protect. The system was designed to solve the problem of the North Korean Missile Threat, and thereby keep the United States and its interests safe from the rogue nation. It answers the threat with consideration given to the phases of the missiles trajectory and its range. The PAC-3 is a battle-proven component of the ground-based missile defense, and the Interceptors and

THAAD have both succeeded in intercepting missile targets during operational tests. The analysis illustrates that the United States' system is fully capable of deterring the rogue country from once again reneging on its agreement and resuming it weapons pursuits in a first step toward launching an attack against the United States. However, the question of whether it will, in fact, act as a deterrent remains and ultimately decides the effectiveness of the United States' Missile Defense System against the North Korean Missile Threat.

Modeling provides an analytic framework utilizing Game Theory's principles of strategy and risk calculation to illustrate what the likely outcome of this very dangerous game of ballistic missiles. By first assigning payoff numbers to the United States' strategies of missile defense and diplomacy and North Korea's strategies of diplomacy and missile proliferation, the game proceeds to determine the likely outcome of the combined strategies. The result of the gaming matrix is a Prisoner's Dilemma, meaning that each party will elect to better themselves by betraying any promises made to the other party. Given this scenario, the modeling analysis depicts a situation where the United States holds all the Aces, but North Korea has the trump card. History will repeat itself; North Korea will once again renege on its agreements because they have everything to gain and little to lose, and when it occurs the United States will once again utilize diplomacy in an effort to defuse the North Korean Missile Threat.

A. RECOMMENDATION

The United States' National Missile Defense System in itself is not an effective deterrent to the North Korean Missile Threat. The United States need to up the ante. North Korea believes the United States will continue to utilize diplomacy when dealing with them, and Washington has not provided credible persuasion to the contrary. The SEDP has shown the system can perform as both a deterrent and a protective measure, but Game Theory shows that, in regards to North Korea, it simply won't act as a deterrent. To change the outcome, the United States must employ a different strategy by playing a card it

has thus far been unwilling to lay down – the next time North Korea readies its systems for a missile launch, test or otherwise, the United States must swiftly ready its systems for an intercept, whether it elects to follow through or not.

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APPENDIX A. THE EFFECTIVENESS OF THE U.S. MISSILE DEFENSE CAPABILITIES AS A DETERRENT TO THE NORTH KOREAN MISSILE THREAT.

A. GAME THEORY TERMINOLOGY

In comprehending the methodology described in this thesis, it is important to define certain terms that are used when applying game theory:

1. The payoff matrix of a game is the matrix wherein each row corresponds to a strategy of a maximizing player, each column corresponds to a strategy of the minimizing player, and the matrix entry is the payoff resulting from the strategy choices of that row and column.

2. Nash equilibrium, named after John Nash, is a set of strategies, one for each player, such that no player has incentive to unilaterally change their action. Players are in equilibrium if a change in strategies by any one of them would lead that player to earn less than if the player remained with its current strategy.

3. A simultaneous game is one in which all players make decisions or select a strategy without knowledge of the strategies that are being chosen by other players. Even though the decisions may be made at different points in time, the game is simultaneous because each player has no information about the decisions of others; thus it as if the decisions are made simultaneously. Simultaneous games are represented by the normal formula and solved using the concept of a Nash equilibrium.

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APPENDIX B. THE EFFECTIVENESS OF THE U.S. MISSILE DEFENSE CAPABILITIES AS A DETERRENT TO THE NORTH KOREAN MISSILE THREAT.

A. THE U. S. STRATEGIC MOVES

First Move:

If the U.S. makes the first move –The U.S. would choose A for an outcome of (2,2)

If The U.S. takes A, then N.K. takes D – giving outcome of 2,2

If The U.S. takes B, then N.K. takes D – giving outcome of 1,4

It does not benefit The U.S. to make the first move

Does THE U.S. have a threat?

The likely outcome is AD (2,2)

The U.S. wants C, puts threat on D

Threat if N.K. takes D, the U.S. takes B – giving outcome of 1,4

Normally if N.K. takes D, the U.S. takes A – giving outcome of 2,2

The new outcome does not benefit the U.S. but does help N.K.

The U.S. does not have a threat

Can the THE U.S. make a promise?

THE U.S. wants C, promises not to take B (eliminating BC)

Promise if N.K. takes C, the U.S. takes B giving 3,3

Normally if N.K. takes C, the U.S. takes A giving 4,1

This new outcome hurts the U.S. and benefits N.K.

The U.S. does have a promise

Will the promise work alone?

If N.K. takes C, the U.S. takes B giving outcome of 3,3

If N.K. takes D, the U.S. takes A giving outcome of 2,2

The U.S. will choose B for an outcome of BC (3,3)

The promise will work alone. If the U.S. can make the promise legitimate, it can improve both players' outcome from AD (2,2) to BC (3,3).

B. N.K. STRATEGIC MOVES

First Move:

If N.K. makes the first move – N.K. would choose D for an outcome of (2,2)

If N.K. takes C, then the U.S. takes A – giving outcome of 4,1

If N.K takes D, then the U.S. takes B – giving outcome of 2,2

It does not benefit N.K. to make the first move

Does N.K. have a threat?

The likely outcome is AD (2,2)

N.K wants B, puts threat on A

Threat if the U.S. takes A, N.K. takes C – giving outcome of 4,1

Normally if U.S takes A, N.K takes D – giving outcome of 2,2

The new outcome does not benefit N.K. but does help the U.S.

N.K. does not have a threat

Can the N.K. make a promise?

N.K. wants B, promises not to take D (eliminating BD)

Promise if the U.S. takes B, N.K. takes C giving 3,3

Normally if the U.S takes B, N.K. takes D giving 1,4

This new outcome hurts N.K. and benefits the U.S.

N.K. does have a promise

Will the promise work alone?

If the U.S. takes A, N.K. takes D giving outcome of 2,2

If the U.S. takes B, N.K. takes C giving outcome of 3,3

N.K. will choose C for an outcome of BC (3,3)

The promise will work alone. If N.K. can make the promise legitimate, it can improve both players' outcome from AD (2,2) to BC (3,3).

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APPENDIX C. THE EFFECTIVENESS OF THE U.S. MISSILE DEFENSE CAPABILITIES AS A DETERRENT TO THE NORTH KOREAN MISSILE THREAT.

A. PLAYERS SECURITY VALUES

Having determined that neither the U.S. nor N.K. can improve by unilaterally moving from its dominant strategy, it becomes essential to analyze each player's game to determine if there is the possibility of improving an outcome by playing one player's side. Figures 1 and 2 show the result of both the U.S. and N.K. games. In each game, the objective is for the player whose game is being analyzed to maximize its outcome while the opponent attempts to minimize the other player's outcome. The end result determines each player's security value.

1. U.S. Game Options

U.S. objective – Maximize Outcome

N.K. objective – Minimize Outcome

U.S. Security Value – 2

		DIPLOMACY	MISSILE PROLIFIRATION
U.S.	MISSILE DEFENSE	4 →	→ (2) ↑
	DIPLOMACY	3 → ↑	→ 1 ↑

2. N.K. Game Options

N.K. objective – Maximize Outcome

U.S. objective – Minimize Outcome

N.K. Security Value – 2

	N.K.	
	DIPLOMACY	MISSILE PROLIFIRATION
MISSILE DEFENSE	1	2
DIPLOMACY	3	4

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