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MITIGATING CRITICAL VULNERABILITIES IN U.S. NUCLEAR DEFENSE STRATEGY

by

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ABSTRACT

This paper examines three core outlets for addressing the Intercontinental Ballistic Missile (ICBM) threat: missile defense, nuclear deterrence, and nuclear diplomacy.The United States remains vulnerable to ICBMs fielded by nuclear peers, Russia and China; its nuclear defenses would likely be overwhelmed in the event of a nuclear war. Applying the Problem/Solution framework, this studydemonstrates that nuclear diplomacy isan under-utilized outlet that provides alow-cost solution for a substantial gain in increased safety from ICBMs.Nuclear treaties have historically curbed both nuclear weapon production and development. Treatiesdecrease opportunities for miscalculation, and they increase transparency between nuclear competitors. Although treaties are not the complete answer to this significant problem, they must be regarded as an integral component of the solution. Missile defensesystems could provide a viable solution if production of interceptors is substantially increased and the intercept technology is matured. At current production costs, establishing robust missile defenseis not economically feasible. Increasing spending on nuclear deterrence (via nuclear triad) is economically feasiblebecause of the scale of U.S. defense spending compared to its peer competitors; however, this course of action isescalatory in nature and could potentially ignite the nuclear conflict it aims to prevent.

Introduction

The United States is vulnerable to attack from nations capable of conductingmassive ICBMstrikes on the U.S. homeland. U.S. strategic documents lack a consistent, post-Cold Warnuclear defense strategywhich manages escalation and effectively messages diplomatic outlets to nuclear competitors. Nuclear treaties have historically been effective at easing tensions and reducing the probability of a nuclear conflict, but only a few treaty instruments remain in effect. The treaties that remain, particularly bilateral terms between the United States and Russia, require a renewed focusin order to prevent such instruments from becoming obsolete.The U.S. nuclear defense strategyfocuses primarily on two pillars---nuclear deterrence and ballistic missile defense systems. Although the United Stateshas a limited nuclear weapon defense capability,itwould likely be overwhelmed in the event of a nuclear war.[1]Establishing robust nuclear defense is a difficult problem—both because its development runs counter to nuclear arms control effortsand because ICBMsareadvanced, exo-atmosphericweapons that are difficult to intercept. While it may seem unlikely, the use of nuclear weapons in future wars remains a distinct possibility. Deterrence can fail. Military planning is particularly focused onpreparing for contingency operationsin the event that deterrence no longer holds.[2]If deterrence in conventional warfare can fail, so can nuclear deterrence. This is because there is no difference in the mechanisms which would ultimately lead to a nuclear war; such a conflict would simply possess ahigher threshold of costs thattwo opposing nations would be willing to bear.

Utilizing the problem/solution framework, this research paper revisits U.S. nuclear defense strategy, and it developscourses of action for improving the nation's nuclear defensive posture: *How can the United States enhance its nuclear defensive posture and mitigate critical vulnerabilities currently present in its nuclear defense strategy?* This research paper will

explore solutions along three general courses of action: 1) increasing nuclear defenses; 2) reinforcing deterrence; and 3) re-establishing treaties with nuclear peer competitors. The evaluation criteria for achieving substantive improvements in U.S. nuclear defense strategy is based on the following: 1) Is the United States safer from the risk of a nuclear attack?; and 2) Are the changes to policy and/or strategy economically viable?

Background

Nuclear weapon technologies continue to be developed by the three major nuclear powers (United States, China, and Russia), and aspiring nuclear weapon states continue to pursuenuclear weaponcapabilities (North Korea and Iran). During his address to Iran on January 8th, U.S. President Donald Trump indicated that the United States is producing "many hypersonic missiles,"[3]indicatingdevelopment of aweapon technologycomparable to Russia's Avangardnuclear hypersonic glide vehicle.[4]Russia claims that this new delivery vehicle is capable of evadingall U.S. missile defense systems.[5]Additionally, Russia's new RS-28 SarmatICBM advertisesa capability of destroying a land mass the size of Texas or France.[6]The 2018 Nuclear Posture Review (NPR) indicates that China's nuclear force is expanding.[7]Following the U.S. strikes in Iraq which killed Iranian General QassemSoleimani, Iran announced complete withdrawal from any remaining commitments to the Joint Comprehensive Plan of Action (JCPOA)[8]. North Korea, similarly,made a public statement in December of 2019 that it will resume missile testing contrary to thesummit agreement with the U.S. in Singapore, 2018.[9][10]These are indications of an on-going nuclear arms race, though at a different scale and pace compared to the peak of the Cold War Era. As nations continue to develop more capable nuclear weapons, it is apparent that treaties among nuclear powers are in

jeopardy of becoming obsoletebecause they are no longer providing an effective cap on the development and stockpile limits of nuclear weapons.

Nuclear Threat

Gaining a full appreciation of the extent of the U.S. vulnerability to a potential attack from nuclear weapons requires a detailed understanding of the threat (including Russia, China, and eventually North Korea and Iran if they become ICBM capable), the threat environment (i.e. trajectory path from launch to termination), and the shortcomings of U.S. missile defense systems. The scope of this vulnerability will be confined to ICBMs, as other nuclear weapon delivery systems already have substantial mitigating measures. As an example, enemy aircraft delivering nuclear weapons could be countered with opposing fighter aircraft. China and Russia are the only two non-allied nations capable of reaching the continental U.S. with an ICBM nuclear warhead.[11] The numbers of nuclear warheads and launch platforms officially declared by each nation are as follows:

- U.S.: 1,350 strategic warheads deployed on 652 launch platforms, including ICBM missile silos, SLBM, and strategic bombers; 4,000 non-retired warheads stockpiled.
- Russia: 1,444 strategic warheads deployed on 527 launch platforms, including ICBM missile silos, SLBM, and strategic bombers; 4,500 non-retired warheads stockpiled.
- China: 270 total warheads (not all strategic) deployed on 75-100 launch platforms, including ICBM missile silos, ICBM mobile, and SLBM.[12][13]

ICBMs have three phases of flight: boost phase-occurs when the missile launches from the ground launch platform (silo, mobile launcher, etc.), traveling through the atmosphere into space; midcourse phase-the booster separates from the missile, and the missile travels along a ballistic trajectory in space towards the target; terminal phase-re-entry into the atmosphere and descent onto the target.[14] The Ground-based Midcourse Defense (GMD) system is the platform specifically tasked with defending against ICBM weapons. It isdesigned to intercept an ICBM during the longest interval of the ballistic missile's flight trajectory, midcourse.[15] GMD intercept

is enabled by a C2 infrastructure including remote infrared detection of a ballistic missile launch, ground-based radars which track the missile, and computer display/information processing systems.[16] The FY18 Defense Authorization Act established funding for 20 additional GMD interceptors by 2023, and it calls for the identification of deployment sites on the East Coast or Midwest for 104 additional GBIs.[17]Count for count, the current and projected interceptor numbersarenot even close to what would be required to defend against the two nuclear rival's arsenals. The Director of Operational Test and Evaluation (DOTE) report from FY 2017 publiclyrevealed that the GMD system deployed in the United States is only capable of defending against a small number of IRBM or ICBM weapons which have simple countermeasures.[18] Additionally, GBI interceptor tests have demonstrated a less than perfect track record, achieving a rate of 11/29successful intercepts to date.[19]

Nuclear Defense Strategy

Fragments of U.S. nuclear defense strategy arescatteredacross multiple official, strategic documents. The broad, overarching nuclear defense mandate is delineated inthe National Security Strategy (NSS) and National Defense Strategy (NDS). In the NSS, it stems from this statement:"Our fundamental responsibility is to protect the American people, the homeland, and the American way of life."[20]Nuclear deterrence is discussed as a cornerstone of ensuring peace and stability, and the NSS further emphasizes that nuclear weaponsare integral to deterring aggression against the United States and its allies."[21]Fundamentally, deterrence involves forcing an opponent to calculate that the costsof military actions outweigh its potentialbenefits. Nuclear deterrence operates under the same guidelines, but with weapon systems of a substantially largerscale. The importance of nuclear deterrence is further discussedin the 2018 Nuclear Posture Review (NPR).[22] The NPR reveals substantial insight regardingthe current

administration's intentions forpotential employment of nuclear weapons.Noteworthy points include the recapitalization and modernization of nuclear triad capabilities,[23] the development of non-strategic, low yield weapons carried by submarines,[24] emphasis on supporting the Non-Proliferation Treaty (NPT)[25], the stated intention to negotiate the New START treaty in 2021, and a provision for renewinga commitment to arms control efforts.[26] The central theme prevalent in the NPR is a renewed focus on Russia and China as competitors within a "Great Power Competition," a term also prevalent throughout the NSS and NDS.[27]A case is made for reinforcing deterrence to counter Russia and China's efforts at developing new nuclear weapon technologies and increasing weapon inventory counts.[28]

Having more, stronger nuclear weapons has a strong preventative effect in dealing with present or aspiring nuclear powers. Iran, as an example, has historically maintained a diplomatic and military posture short of provoking a full-scale confrontation with the United States. This is based on a rational calculation that it would not win a conventional war against the United States; the fact that the United States possesses nuclear weapons compounds this effect. U.S. possession of strategic nuclear weapons combined with its refusal to adopt a "no first use" policy forces any opposing nation to factor complete devastation or a decapitation nuclear strike into their decision-making calculus—despite international treaties or proportionality norms mandated by the Law of Armed Conflict.[29]Following the U.S. strikes which killed Iran General Soleimani on Jan 3, Iran responded by launching ballistic missiles in vicinity of U.S. military positions in Iraq that resulted in no U.S. servicemembers being killed.[30] This measured response with a very limited effect prevented further escalation and is likely due to Iran's reluctance to ignite an open conflict with the United States. President Trump drew a very clear red line regarding any Iranian retaliatory response, publicly stating via Twitter that if Iran struck any Americans or American

assets, it "will be hit very fast and very hard.."[31] Iran had lost a top leader in its military, and it could effectively do nothing in return. Although bound by an obligation of proportionality according to international law, the fact that the United States possesses a substantial nuclear arsenal in addition to a conventional military edge places Iran in a weak position when dealing with the United States diplomatically. If Iran hypothetically possessed a limited nuclear weapon capability during these events, it is likely that it would behave similarly, following the same logic that forced it to de-escalate and further prevent a war that it could not win. These events demonstrated that a competitor with a weaker force (nuclear or otherwise) will tend to seek de-escalation rather than head-on conflict with a stronger opponent.

The second component to U.S. nuclear strategy is missile defense, which utilizes missile defense platforms that are ground, sea, and space-based.[32]Missile defense falls underUnited States Strategic Command's purview. STRATCOM's missile defense mandate isreflected inits public mission statement: "USSTRATCOM deters strategic attack and employs forces, as directed, to guarantee the security of our nation and our allies."[33] The two key missile defense organizations under STRATCOM include the Joint Functional Component Command for Integrated Missile Defense (JFCC IMD) and the Missile Defense Agency (MDA).NSS and NDS reference nuclear defense in only a few, brief statements. The NSS discusses employment of a "layered missile defense system" purposed with defending against missile threats by North Korea and Iran.[34] Directing the missile defense system towards rogue nations is significant because missile defensescan catalyze anuclear arms race between nuclear competitors. This statement is therefore indirectly aimed at Russia and China, the two nations most likely to develop nuclear weapons which could defeat U.S. nuclear defenses. Their reaction to increased defensescould be tofurther develop weapons which could defeat such defenses in order to

preserve their nuclear weapons' deterrent effect. Additionally, the NSS indicates that missile defense will include the capability of destroying an enemy's nuclear missiles before they are even launched.[35] The NDS provides a similar statement, lacking only the latter point regarding pre-emptive launch.[36]Development of robust nuclear defenses is problematicfornuclear treaty agreements. If a nation suddenly developed complete defense againsta competitor's nuclear weapons, the competitor's nuclear weapons would effectively lose all deterrent value. That competitor would then develop countermeasures or stronger nuclear weapons to penetrate any nuclear defenses. The end result is a protracted arms race. Recognition of this pattern--rival nuclear powerscontinuously outmaneuvering one another with nuclear offensive and defensive weapon developmentis what led to the development the Anti-Ballistic Missile (ABM) Treaty of 1972.[37] ABM called for limiting the number of deployed defense missiles to a maximum of 100.[38]The United States withdrew from ABM in 2002.[39]The current administration's position onBallistic Missile Defense (BMD) is discussed extensively in the Missile Defense Review (MDR) of 2019. While the NSS carries a softer tone towards Russia and China, designated as "revisionist powers," the MDR directs the U.S. missile defense system towards both of them in addition to rogue nations (Iran/North Korea).[40]

The MDR acknowledges the need for a contingency plan in the event that deterrence fails, and it calls for Comprehensive Missile Defenseto defend against a complex missile threat.[41]It further calls for a multi-layered approach in accomplishing this.[42]The multi-layers include land-based, sea-based, and space-based platforms capable of detecting and engaging ballistic missiles in varying phases of a nuclear missile's flight.[43]Such platforms include BMD ships (Aegis class Destroyers and Cruisers), Aegis Ashore, Terminal High-Altitude Area Defense (THAAD), and the Patriot Advanced Capability (PAC-3) Missile Platform, and the

Ground-Based Midcourse Defense System (GMD).[44]GMD employs Ground-based Interceptors (GBI) located in Vandenberg Air Force Base, CA and Fort Greely, AK. The MDR acknowledgesthat GMD provides limited protection against the ICBM threat, and theviability of the system as a defense platform has been in question since its deployment.[45] Although GMD has aless than perfect track record (11/19 successful attempts), the United States has a history of successful missile tests that go back to the Cold War.During the 1960's, the U.S military was developing the NIKE ZEUS project, which was an early attempt at nuclear missile defense.[46] The missiles were originally designed as proximity detonation weapons (with nuclear warheads), so the objective was to get within close enough proximity to an inbound ICBM. Consequently, the accuracy required for a successful intercept was lower than today's missile defense system, which utilizes direct contact with an Exo-atmospheric Kill Vehicle(EKV).[47] Testing for the NIKE ZEUS program resulted in a 9/13 successful intercept rate.[48]This is not a perfect track record, but it demonstrates that missile defense is not an untested concept. It has been proven physically possible on multiple iterations.If missile defense is to become a preeminent ICBM solution, it would require a concerted effort to mature the technology and significantly improve the missile test track record.

Criteria

As stated previously, a solution to this research problem will be evaluated on two criteria: 1) whether the United States is safer from the risk of a nuclear attack (homeland safety); and 2) whether the changes to policy and/or strategy are economically practical (fiscal feasibility). Criterion 1 is measured by the likelihood of being attacked by ICBMs. Key inputs include probability of confrontation with a nuclear competitor, overall nuclear weapon counts, and the capabilities of nuclear defenses. Missile defenses will be measured by their ability to defend

against a significant attack from ICBMs, accounting for scaled production and current success rates of ICBM vs. interceptor tests. From a foreign policy standpoint, success in making the Homeland safer from a nuclear attack is measured in potential success of arms reduction measures and the ability to avoid escalation. Reinforcing nuclear deterrence hasbeen thepreferredmethodconfronting this problem. Nuclear deterrence has held for decades, and the stability it has brought makes this course of action worth considering further—specifically, how to strengthen it. All courses of action will be evaluated based on economic practicality which will be derived from DOD budget constraints.

Alternatives Examined

The evaluation criteriaare applied to the three proposed courses of action. COA 1: Boost ICBM defenses/Missile Defense. Satisfying Criterion 1 requires that scaled production of missile interceptorssubstantially reduces the threat from ICBMs. As previously indicated, U.S. GMD's capabilities and scale require substantial improvement in order to address the threat posed by nuclear competitors. Although missile intercept tests to datehave a success of just above 50%, critics tend to overlook the fact that the intercepts that were successful have demonstrated11 times that such a difficult challenge as "hitting a bullet with a bullet" is possible.[49]The most recent GMD test, taking place 25 March 2019, provided a successful proof of concept of employing a "salvo doctrine" with respect to missile defense.[50]An ICBM target/test missile originatingat the Reagan Test Site, Republic of the Marshall Islands was destroyed by a combination of two GBIs fired from over 4,000 miles away at Vandenberg Air Force Base, CA.[51]Accomplishing the task of midcourse intercept outside the atmosphereis beyond proof of concept—shortcomings are likely attributed to other factors including the procurement process

and funding constraints.Missile testing from the 1960's further proves that missile defense, though difficult, can be accomplished.[52]

The push for GMD development began under the Bush Administration in 2001. It was advertised as a response to Iran and North Korea's publicized nuclear intentions, and it wasjustified under broad powers provided by the post-9/11 era.[53]The timeline for development was compressed in order to quickly establish the defensive capability; consequently, normal research and developmentprocesses were circumvented. All GBIs were installed with prototype missiles that had not yet been tested when they were initially deployed in 2014.[54]The Missile Defense Agency, tasked with development and readiness of GMD, has also suffered from numerous bureaucratic-related setbacks throughout the course of GMD development. A review by the Inspector General in 2014 yielded findings of 48 violations of aerospace standards pertaining to development of the EKV.[55]The Government Accountability Office (GAO) made critical observations of the MDA as recent as last year (2019), stating that the agencyappeared to have a very "schedule driven approach."[56]Less than optimal production/developmenttimelines and costs for GMD can likely be attributed to bureaucratic and political factors, not theviability of the technology itself.Scaled production of GBIs to defend against the greater of the two nuclear competitors, Russia, would require at a minimum matching every deployed warhead (including multiple warheads installed on every single ICBM) and accounting for the theoretical success rate of interceptor missiles (appx. 50%). This equates to2,888 interceptors. As unreasonable as 2,888 total missiles for the defense system may seem, initial plans for missile defense under the Kennedy Administration in 1961 included fielding 1,200 missiles.[57]Although it is unlikely that GBIs could intercept every inbound ICBM during a hypothetical nuclear missile barrage, scaled production matching Russia's deployed warheads count for count would

substantially reduce the threat. Additionally, scaled production and subsequent missile defense testing would likely improve the intercept technology.COA 1 meets Criterion 1, on the basis that historical/modern day testing has proven that it works despite its recent 11/29 success rate. Fielding 2,888 interceptors would likely reduce the ICBM threat substantially.

The feasibility of boosting missile defense (Criterion 2) is determined by its relative cost in relation to the DOD budget. The most recent contract to field 20 additional Ground-based interceptors was awarded in Jan 2018 to the Boeing Company for $6.6 billion.[58] The timeline for completion under this contract is development/delivery by 2023. [59] A total of 44 GBIs have been deployed since 2002.[60] The initial 40 GBIs were fielded at a cost of $40 billion, and this occurred over the course of 15 years (2002-2017).[61] The cost per GBI according to the most recent contract (Jan 2018) is $330 million per interceptor.[62]Cost comparison between the GBI and an ICBM yields additional insight as to whether this is a viable solution to the problem. Recent U.S. budget estimates for replacing the 440 Minuteman III[63] missiles put the total cost at $85 billion, which amounts to almost $200 million per missile.[64] The cost of a single GBI is comparable, but it is still approximately 33% more expensive. Taken a step further, the 440 Minuteman III ICBMs are currently fitted with a single warhead, but they have the capacity for an additional two nuclear warheads (total of three per ICBM).[65] Depending on the terms to be lined out in the New START treaty which is up for renewal in 2021, the number of warheads per ICBM could be increased, likely driving the cost per warhead down significantly.

The fact that the GMD has an unfavorable cost per interceptor compared to its ICBM counterpart is less than ideal; however, scaling production could still be justified even at the current cost.The cost to produce a 2:1 ratio (minus the 44 GBIs currently deployed—total of 2,844 missiles) amounts to $938 billion. If installed over 10 years ($93.8 billion per year), this

quals13% of the total DOD budget (FY20=$718 billion)and 7 times the combined nuclear triad + missile defenseexpenditures (FY20=$12.9 billion, including Procurement, R&D, Test and Evaluation).[66]Scaled production of the Tomahawk Cruise missile showed areduction in the annual cost per unit of approximately 50% when going from the production of 6 units (1980-$4.2M) up to 475(1988-$2.01M).[67] Even if GBIs achieved the full effect of scaling production reflective of the Tomahawk, the cost is still 3.5 times the current nuclear budget, and it consumes 6.5% of the total DOD budget. Either the DOD would have to make sacrifices in non-nuclear defense-related spending, or it must substantially reduce the cost per GBI by renegotiating contract vehicles or committing to large-scale production of the intercept missiles. For the purpose of this paper, COA 1 fails the feasibility criteria; however, to put this total cost in perspective, the FY20 DOD budget includes $173.8 billion for Overseas Contingency Operations (OCO).[68] If U.S. political leadership determined that the existential threat posed by ICBMs was greater than its limited security interests in the Middle East (NSS prioritizes great power competition posed by Russia and China over conflict in the Middle East), the DOD could easily pay for 2,844 GBIsover a ten year period at current cost per missile estimates.

COA 2: Reinforcing Nuclear Deterrence. U.S. nuclear deterrence is based on the credible threat and capabilities of the nuclear triad, consisting of strategic bombers, land-based ICBM silos, and ballistic missile submarines.[69]COA 2 would entail the increase in production and development of nuclear weapons, whichultimately influences the nuclear weapon development decision-making of other nations (nuclear or otherwise).Determining if the United States is safer from an ICBM attack under this COA (criterion 1) depends onwhether reinforcing deterrence increases the chance of nuclear war with nuclear competitors. Historical examples will be examined which reflect the conditions of a nuclear buildup. Military buildups are

provocative, and they increase tensions. Nuclear weapon buildups are no different; however, they have a stronger messaging effect and they increase the opportunities for miscalculation/misinterpretation of intentions. Examples of signals at present include announcements of ballistic missile tests by North Korea or public statements made by Russia that it is developing an unmanned nuclear torpedo that could hit the west coast of the United States.[70] If a nuclear arms race is reinvigorated, there would likely be more rhetoric, more missile tests, and more announcements of nuclear missile developments. The current estimate of nuclear weapons throughout the world is approximately 14,000.[71] Near its peak, the combined U.S.-Russian total nuclear stockpiles totaled 61,682 as of 1987.[72] No nuclear conflict ever took place from the onset of the Cold War arms race until today; however, it is worth examining a few instances when it came close. Such investigation could yield insight as to whether the mechanics which prevented a conflict then (at the height of the Cold War) would still be valid in modern times. The two events during the Cold War that will be examined includethe Cuban Missile Crisis in 1962 and the Able Archer exercise of 1983.

The Cuban Missile Crisis is the most renowned event taking the United States very close to the brink of nuclear conflict during the Cold War era. To recap briefly, the United States opposed diplomatically the Soviet build-up of bombers and ballistic missiles after learning of their deployments to the island of Cuba.[73]During this time frame, the U.S./Russia nuclear weapon count was U.S.-25,540, Russia 3,322.[74] President Kennedy ordered a "quarantine" of all vessels bound from Russia to Cuba, and he publicly warned the Soviet Union that any missile launch from Cuba would be considered as an attack on the United States. In response, Nikita Khrushchev, head of the Soviet Communist Party and defacto head of state of the U.S.S.R., stated publicly that the U.S. quarantine was an act of an aggression.[75] Further, all Soviet vessels would proceed regardless.[76] A U2 spy plane produced imagery that ballistic missiles were close

to operational readiness in October 1962, and U.S. military forces were placed on DEFCON 2 readiness status, which indicated imminent strike involving U.S. Strategic Command.[77] Backdoor communication channels allowed the Soviets to indicate that they wanted to de-escalate and prevent a nuclear conflict based on terms outlined in a message sent from Khrushchev to Kennedy.[78] Soon afterward, the United States struck a deal with the Soviet Union—the ballistic missiles would be dismantled in exchange for a promise that the United States would not invade Cuba. From this event, a crisis brought the two nuclear powers to heightened conditions of readiness, and both perceived the very real possibility of a confrontation with nuclear weapons. Khrushchev's communication channel to the United States indicated a strong desire to avoid conflict despite public statements and rhetoric. This reflects a rational state actor calculating that the cost of a potential nuclear war outweighed the benefits. Nuclear deterrence worked in this instance; however, this snapshot in history is widely viewed by experts as the closest the United States has ever come to nuclear war.[79]

A second incident which nearly sparked a nuclear confrontation took place more than twenty years later. At the onset of the Able Archer exercise in 1983, Russia had been closely monitoring U.S. activity and incorrectly interpreted signals of U.S intentions. Yuri Andropov, head of the KGB and key leader in Russian politics, believed that the United States intended to conduct a first strike against the Soviet Union under the mask of "exercise" activities.[80] Russia at this point in time possessed a greater number of nuclear weapons (35,804) than the United States (23,305).[81] In November of 1983, following notifications of a perceived NATO force increase in readiness (which presumably could have been in preparation for a U.S. nuclear strike) the Soviet Union armed its strategic bomber force with nuclear weapons, placing 70 SS-20 IRBM missile launchers on "high alert," and ordering nuclear submarines to take position under

the arctic ice.[82] The exercise passed without triggering a nuclear war, but Soviet nuclear forces were placed at the highest level of readiness based on misinterpretation of signals derived from the actions of United States and NATO allies during an exercise. Rational actors can misinterpret and miscalculate—such an event could happen in the present day even though the circumstances and signals would be different. Undergoing further nuclear weapon development and potentially increasing the number of warheads would leave a trail of signals and actions that peer competitors/nuclear adversaries will inevitably perceive, interpret, and respond to. Taking into account these two historical events of the Cold War, doubling down on nuclear deterrence would likely provoke nuclear competitors and increase the opportunities for miscalculation—the United States would not be safer from nuclear attack as a result.

Measuring the economic feasibility of COA 2 is accomplished bycomparing the strengths of economies and defense budgetsamong nuclear competitors. This course of action entails production/procurement of offensive nuclear weapons regardless of the risk of another arms race, ensuring that no other nuclear competitor possesses stronger nuclear weapons. Additionally, these nuclear weaponswould have to keep pace with countermeasuresin order todefeat other nation's missile defenses. Satisfying Criterion 2 depends on whether the United States can sustain such an arms race. Maintaining nuclear deterrence is a question of resources allocated for Research and Development and weapons procurement. Maintaining an arsenal of nuclear weapons is expensive, and it effectively diverts resourcesinto massive weapons that could likely go unused for decades. Therefore, the sacrifice made by a nation to field and maintain new nuclear technologies must be small enough to be sustainable.It follows that the nation which maintains an economy with the strongest GDP (resulting in the ability to spend the most money on nuclear weapons)could theoretically outspend other nations in a nuclear arms race. U.S.

Nominal GDP according to the International Monetary Fund (IMF) 2019 World Economic Outlook amounted to $22.32 Trillion. Comparatively, China's economy totaled $15.27 Trillion, and Russia's economy was at $1.66 Trillion.[83] The U.S. economy in 2019 held nearly a quarter of the world'scombined GDP, a staggering figure which explains its ability to build and maintain its military.Comparing defense spending budgets provides further illumination. U.S. defense spending in 2018 was higher than the next seven nations combined.Defense spending as a percentage of GDP indicates the share of total resources devoted to national defense. Comparing the top three nuclear powers shows a fairly comparable level of defense spending as a percentage of GDP, but the United Statesoutspends China by factor of 2.6, Russia by a factorof 10: United States-$649b/3.2%; China-$250b/1.9%; Russia-$61.4/3.9%.[84]

The dollar amount specifically spent on nuclear weapons is more difficult to obtain. The FY20 budget for the U.S. DOD included $6.5 billion for expenditures related to nuclear triad and $6.5 billion for missile defense.[85]In 2011, the Russian First Deputy Defense Minister advertiseda budget of 19,000 billion Rubles ($325.7 billion) in Russian defense spending for the period of 2011-2020, 10% of which would be allocated "for the procurement of new weapons, the repair and modernization of existing military hardware and R&D would be allocated to the modernization of the nuclear triad."[86] From this number, it is estimated that 60.7 billion Rubles ($1.8 billion) were allocated in 2010 and 140 billion Rubles ($2.5 billion) in 2016 towards the development of nuclear munitions. Rough comparison(though in different years of spending) shows that U.S. spending on its nuclear triad component alone is over 2.5 times that of Russian spending on the same over the course of a single year.Additionally, U.S. defense spending on its nuclear triad is less than 1% of the total budget. These figures are a clear indication that the United States is in a strong position to outspend Russia in the event of a rekindled arms race.Circling back to the feasibility criterion--it is fiscally and economicallyfeasible for the

United States to either maintain or expand its nuclear triad capabilities and reinforce nuclear deterrence.

COA 3: Reconstitute treaties with nuclear competitors.Nuclear weapon treaties can directly influence ICBM production and development, and they can substantially curb the size and scope of the nuclear threat.They effectively provide an upper limit on the production of nuclear weapons. While there are several initiatives aimed at limiting both nuclear proliferation and nuclear weapon development, there are actually only a few nuclear treaties currently in effect. Some of the notable multi-lateral treaty efforts include the Partial Test Ban Treaty (PTBT-1963), the Non-Proliferation Treaty (NPT, 1970), and the Comprehensive Test Ban Treaty (CTBT-1996). Among these treaties, only the Partial Test Ban Treaty (PTBT), signed by the United States, United Kingdom, and Union of Soviet Socialist Republics in 1963 is still in effect.[87] PTBT's enforcement measures are not that strong; although the treaty calls for banning nuclear weapon testing efforts, its inspection/verification measures are voluntary in nature.[88] NPT has been a successful multilateral treaty instrument across the broadest number of nations. As of 2010, it was ratified by 190 nations.[89] Within the treaty, all parties agree to "pursue general and complete disarmament, and non-nuclear weapon states agree to forgo developing or acquiring nuclear weapons."[90] NPT failed to become fully ratified during its 2015 renewal summit due to disagreements over treaty implementation measures; the treaty is up for conference again in 2020.[91] CTBT by design was intended to replace PTBT. CTBT provides stronger measures of control and has broader number of signatories;[92] however, although being open for signature since 1996, it has not yet been ratified by all party nations.[93] this treaty has been signed by the Russian Federation and not the United states.[94]

Bilateral treaties between nuclear powers provide a different outlet for curbing nuclear arms' development and production. Unlike multilateral treaties such as NPT, which had 190 signatories, only two nations are required to sign a bilateral treaty in order for it to become effective. No bilateral treaties between the United States and China have been drafted to date. Treaties between Russia and the United States go back to the height of the Cold War and many have undergone numerous iterations. These include the Strategic Arms Limitation Talks (SALT) treaties (1969 to 1979), the Intermediate Range Nuclear-Force Treaty (1987-2019), the Strategic Arms Reduction Treaties (START) from 1991 to 2001, and Strategic Offensive Reductions Treaty (SORT-2002).[95] Measures implemented throughout these treaties have included limiting future construction of ICBM silos, capping the number of nuclear delivery vehicles produced, imposing limits to strategic nuclear warheads, and even the dismantle/destruction of warheads in respective nations' nuclear inventories.[96] Under the President's specific direction, the United States withdrew from the INF treaty on August 2, 2018, citing Russian violations of intermediate range nuclear weapon deployments that Russia disputes.[97] All other treaties with Russia have expired except for the New START treaty, ratified by both nations as of 2011.[98] The New START agreement caps strategic nuclear warheads at 1,550, and it imposes a maximum of 800 delivery systems including both deployed and non-deployed launchers.[99] Russian President Vladimir Putin has indicated a willingness to continue with New START, in addition to renegotiating INF.[100] Unlike INF, there is a strong consensus among U.S. experts that Russia is currently in compliance with the terms of New START.[101] President Trump has signaled a similar willingness to engage on New START, but with modifications that would make the terms applicable to China as well.[102] New START therefore offers a real opportunity to engage with two nuclear rivals in an effort to curb further nuclear weapon development and

procurement.[103]Nuclear treaties could potentially be a viable solution to making the U.S. homeland safer from an attack by nuclear weapons.

Assessing COA 3 based on the first evaluation criteria requires an examination how effective the treaty instruments were during the Cold War—specifically how effective it was at curbing the nuclear warhead count. The intent of treaty frameworks is to effectively place an upper limit on nuclear weapon production. Additionally, they bring nuclear powers into regular dialogue and increase opportunities for de-escalation. The first bilateral treaty brokered between the United States and the Soviet Union was SALT I, signed in 1972. Under this agreement, the number of ICBMs and Sub-Launched Ballistic missiles was effectively frozen; however, the treaty did not address the number of warheads allowed per Multiple Independent Reentry Vehicle (MIRV) or nuclear weapons attached to strategic air forces.[104] This allowed either side to continue building their nuclear forces as long as the weapons were not sub-launched (*ICBMs could be fitted with additional warheads). SALT II, signed in 1979, capped the number of delivery vehicles launched by ICBM silos, submarines, and air forces at 2,250.[105] Despite these treaty agreements, the combined U.S.-Russian nuclear warhead count actually increased dramatically from 40,994 up to 52,073during this 7-year period.[106] The Soviet Union nearly doubled its warhead count during this time frame.[107] The descent from peak nuclear weapon count (1987) to present day began with the INF, further accelerating after the collapse of the Soviet Union in 1991.[108] Under INF, both the United States and the Soviet Union agreed to destroy/dismantle all IRBMs, but this only amounted to approximately 2,600 warheads—a small fraction of total warheads within either nation's inventories.[109] A subsequent decline in overall number of combined U.S./Russian warheads occurred between 1990 and 1995 (reduction from 58,392 to 37,904).[110] This is likely attributed to economic pressures associated with the collapse

of the Soviet economy as well as on-going dialogue with START I and II. START I was ratified by the United States and Soviet Union in 1991. Under this treaty, a maximum of 1,600 ICBM, SLBM, and long-range bombers could be maintained by either side. Unlike SALT I and II, the START treaties addressed the number of warheads directly, capping the number of total warheads deployed on launcher platforms (including silos, submarines, and long range bombers) at 6,000.[111] START I was complicated by the fact the Soviet Union was dissolved five months after ratification.[112] The Soviet successor states of Ukraine, Belarus, and Kazakhstan effectively inherited the nuclear weapons of the former Soviet Union.[113] In 1994, the United States, Russia, and the three Soviet successor states signed the Lisbon Protocol, which brought each country under the terms of START I.[114]

The drastic reductions in nuclear stockpiles are likely attributed to more than one factor; however, treaties most likely played a key role in reducing the total number of warheads inventoried by Russia and the United States. Additionally, treaty enforcement brought about collaboration and coordination. INF, for example, called for inspection and inventory of the parties' respective IRBMs within 90 days of treaty ratification; it included a provision for 20 short-notice inspections by either side.[115] Complying with these terms requires dialogue, collaboration, and coordination, and it provides a level of transparency between party nations that would be much more difficult to obtain otherwise. From these facts and observations, it can be concluded that treaties effectively make the United States safer from the nuclear threat. Although SALT I and II actually resulted in an overall increase in total nuclear warheads between the United States and Russia, it included a mutually-recognized loophole that went ignored. Stronger subsequent frameworks resulted in more effective measures for enforcing caps on nuclear weapons.

The weaknesses in treaty frameworks stem from the fact that either party can withdraw at any point in time. Treaties are built upon mutual interests, and subsequent events can result in those mutual interests diverging. Additionally, although treaties aim for transparency, nations will tend to mask weakness, show strength, and hide technological advancements outside the scope of the treaty. That being said, nuclear weapon development (in particular ICBM development) is difficult to hide. Nuclear detonations can be detected, missile tests can be observed from remote sensors,[116] and the construction of missile silos is noticeablevia satellite imagery. Commercial satellite imagery revealed North Korea's development of 12 undeclared ballistic missile bases in 2018.[117] China's possible development of a DF-41 ICBM silo was captured in commercial satellite imagery in 2019 in vicinity of Jilantai, Inner Mongolian Province.[118] Unconfirmed analysis by Federation of American Scientists (FAS) included remarkable details of dimensions, access roads, and additional characteristics of China's efforts.[119]In short, compliance with nuclear treaty terms can be verified outside of the inspections allowed by the agreeing nations.

Measuring this COA against the feasibility criterion requires anexamination of costs associated withnuclear weapon monitoring expenses in addition to the status quo Department of State expenditures. Theannual budget for the Department of State proposed for FY20 is only $40 billion.Nuclear treaties require funds associated with inspection and verification that the respective nuclear power is adhering to terms under the treaty.The International Atomic Energy Agency (IAEA) is the United Nations' sanctioned entity tasked with conducting Nuclear Verification among other international functions.[120]The IAEA's operating budget for 2019 was just over $370 million.[121]Enforcement of the JCPOA serves as a sample on the higher end for expenses associated with inspection and verification of nuclear-weapon related activities. A

2016 report by the GAOfound thatthe IAEArequired $10 million per year for a total of 15 years in addition to its normal operating budget in order to accommodate the inspection requirements for JCPOA.[122] Oversight of Iran's nuclear program under JCPOA was invasive, as it allowed for a 24/7 presence of IAEA inspectors in each Iranian Nuclear facility, accumulating a total of 3,000 man-days of observation per year as of 2017, one year before the United States withdrew from the treaty framework.[123]The New START Treaty, by contrast, entails just 18 individualsite visits by both Russia and the United States to view and count the other nations' nuclear weapon inventories.[124]COA 3 meets the fiscal feasibility criterion because there are strong international institutions capable of distributing the costs oftreaty compliance. Such costs borne by the United Statesmake upa small fraction of overall DOD expenditures. Additionally, the status quo in State Department funding should theoretically be sufficient to support on-going, steady state diplomacy with Russia or China.Compared to other solutions which require expenditures in the billions of dollars, diplomacy is by far the cheapest method for curbing the threat of nuclear weapons.

Results of Comparison

Figure 1 shows the results of the COAsversus the evaluation criteria. COA 3, treaty development, distinguishes itself as the only COA to pass both criteria. Treaty development was examined from a historical standpoint, capturing how treaties influenced nuclear weapon count. Additionally,a maturedinternational regulatory architecturehas been established over the decades since the beginning of the Cold War. This nuclear regulatory infrastructure has enforcement mechanisms that enable nuclear powers to regulate themselves and participate in the oversight of nationsvying for nuclear power status or utilizing nuclear energy for peaceful purposes (e.g. JCPOA). Treaties potentially bring transparency from one nuclear power to another, and they

provide a pathway for de-escalation and cooperation that is mutually beneficial.Since the 1970's,the United States and the Soviet Union participated in nuclear talks that resulted in numerous iterations of treaty instrumentsthat placed an upper limit on nuclear weapons. These actions resulted in drastic reductions innuclear weapon stockpiles.The cost to develop nuclear treaties with nuclear rivals is substantially lower than the other COAs.Future treaty efforts would be absorbedin the budget of the State Department, as this function falls under department's bilateral or multilateral diplomacy mandates.Increasing nuclear defense (COA 1) is a viable solution to gaps in ICBM defense; however, numerous setbacks in missile defense testing have weakened the credibility of this approach.COA 1 passes only the first criterion. In the hypothetical event of a "nuclear barrage," a GMD system scaled to match ICBM inventories would likely intercept a significant number of ICBMs. Missile defense has been a problem reaching back to the onset of the Cold War, and scaled production of intercept missiles previously reached mature planning levels under the Kennedy administration although the missiles never reached the execution phase. Producing intercept missiles on the order of thousands is not a new concept—the key limitation would be the cost and political will stretching from Congress to the President. Even if the GMD system is measured by its most recent track record of successful missile tests, it would likely mitigate the damaging effects of an ICBM strike—the United States sustaining significant damage,but averting complete devastation. Nevertheless, scaling missile defenses beyond the Rogue Nation threat (i.e. installing a capability) is unlikely to gain budgetary approval because of a prevailing faith in nuclear deterrence, as exemplified in NSS and NDS. This COA fails the fiscal feasibility criterion because scaling production of a sufficient number of GBIs would bite into 13% of the annual DOD budget. It would require substantially re-arranging Defense spending priorities--this is

theoretically possible, but it would require a level of alertness to the glaring vulnerabilities in ICBM defense which are unlikely to materialize. Additionally, the ICBM warheads cost less to produce than GBIsat current cost per missile.

Course of Action	Criterion 1: Homeland Safer	Criterion 2: Fiscal Feasibility
COA 1: Missile Defense	☒	☐
COA 2: Nuclear Deterrence	☐	☒
COA 3: Treaty Development	☒	☒

Figure 1

COA 2 meets the fiscal feasibility criterion, but it falls short when it comes to homeland security. Nuclear deterrence prevented escalation throughout the decades of the Cold War; however, there were instances when the United States and the Soviet Union came close to sparking a nuclear war. The two instances in this paper illustrate how even rational actors can come very close to miscalculation. Rhetoric accompanying nuclear weapon capabilities, the advertisement of increasing stockpiles, or the conduct of exercisescan provoke a counterbalancing response on the part of peer competitors. Increasing nuclear weapon inventories and developing new weapon technologies inevitably increase tensions and create new opportunities for miscalculation. COA 2 was found fiscally feasible due to the small percent of a huge DOD budget which can service the development of nuclear weapons and resource their maintenance and upkeep. Compared to nuclear competitors, the United States is in a very strong position to participate in a new arms race should such events transpire.

Recommendations

The greatest results for the lowest cost can be attained by adopting a diplomatic posture aimed at reducing the probability of a nuclear conflict, but it would be unwise to rely solely on nuclear treaty development. Although nuclear competitors can realize benefits by

exercisingrestraint on the development ofnuclear weapons, either side can theoretically renege on the terms if mutual benefit is not sustained (expand upon in earlier section of COA 3). Case in point--United States telegraphing intentions ofwithdrawing from INF. Nuclear treaties make the United States safer from an attack by nuclear weapons because they restrain technological development of nuclear weapons and subsequent increase in nuclear stockpiles (thus decreasing opportunities for escalation or provocation),and they foster collaboration and transparency between and among nuclear powers.Additionally, they limit the spending of U.S. treasury dollars on weapons that historically sit idle for the duration of their operational lifetimes. Nuclear treaties have strong historical support by international norms and the organization of the United Nations specifically aimed at curbing nuclear weapons. This "watchdog" infrastructurehas matured over the decades since the onset of the Cold War. The NEW START talks with Russia present an opportunity to prioritize nuclear diplomacy over the next few years. Such actions could reshape the nuclear landscape and set the course for U.S.-Russian nuclear postures which will influence the next decades of nuclear posturing. President Trump indicated the possibility of bringing China into the equation. This would open communication channels and bring a level of mutual transparency and collaboration not yet attained up to this point.

The National Security Strategy does not mention nuclear treaties as a viable pathway towards keeping the homeland safe.If nuclear treaties become the prevailingstrategy for addressingthe nuclear defense gap, such a focus of effort needs to be captured explicitly in the NSS--both to signal to other nations U.S. willingness to deal diplomatically on nuclear issues, and to give the State Department a strong, focused mandate. The diplomacy section of theNSS discusses relationship-building in order to"create trust and shared understanding that theUnited States calls upon when confronting security threats…";[125]however, it prioritizes a show of

strength over diplomatic negotiation.[126]The document carries a provocative tone towards Russia and China, designating them as rivals (great power competitors), and calling for development of new technologies in order to maintain the advantage militarily.[127] Re-working the document to carry a "diplomacy first" focus, at least in terms of nuclear weapons, would be a good first step towards treaty development rather than allocating billions of dollars for new weapons of mass destruction.Re-focusing on the diplomatic path regarding nuclear weapons should result in viewing New START as an effort that cannot fail. Again, prioritizing this in the NSS would be a good starting point. Russia has already signaled a willingness to continue this effort. As the treaty is up for renewal in 2021, now is the time to begin crafting mutually beneficial terms aimed at promoting transparency on nuclear weapons and capping the number of warheads deployed and produced.If stability can be achieved among nuclear powers through nuclear treaties, billions of U.S treasury dollars could be diverted away from massive,apocalyptic weapons that will likely go unused for decades, and towards spending efforts that produce more tangible benefits for the American people.

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