North Korea's Nuclear Futures: Technology and Strategy

JOEL S. WIT
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FEBRUARY 2015

NORTH KOREA'S
NUCLEAR FUTURES SERIES

US-KOREA INSTITUTE AT SAIS

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

North Korea's Nuclear and Missile Programs Poised for Expansion

Pyongyang's nuclear and missile programs appear poised for significant expansion over the next five years, presenting a serious challenge to the United States, Northeast Asia and the international community.

That expansion will benefit from accomplishments achieved from 2009 until 2014, banner years for Pyongyang's nuclear and missile programs. Aside from obvious manifestations—two nuclear and three long-range rocket tests—Pyongyang has conducted other important activities including advances in the development of nuclear weapons, modernization and expansion of the fissile material production infrastructure, the appearance of new road-mobile intermediate-range and intercontinental ballistic missiles and possibly sea-based cruise and ballistic missiles, the development of a rocket larger than the Unha space launch vehicle (SLV) that may have military applications and the modernization of Pyongyang's missile development testing and production infrastructure.

While the scope of activity does not necessarily mean that all of these programs will result in the deployment of more and newer weapons, it is a disturbing indicator of a vibrant and extensive effort to build a larger nuclear arsenal and more capable missile delivery systems.

Impending Rapid Growth of the Nuclear Weapons Stockpile

Pyongyang's current stockpile is estimated to consist of 10-16 weapons, including 6-8 devices fashioned from plutonium and 4-8 from weapons-grade uranium (WGU). This range reflects uncertainty over the number of plants producing WGU (1 or 2), the number of centrifuges employed and the efficiency of their operation.

The plutonium-based weapons have been miniaturized sufficiently to be mounted on the Nodong medium-range ballistic missile (MRBM) and on the Taepodong-2 missile, which can achieve intercontinental ranges. This judgment is based on the reality that North Korea has been working on such warheads for almost 30 years, and may have received relevant designs from the A.Q. Khan nuclear smuggling network in the 1990s or earlier from China, as Pakistan did in the early 1980s.

Devices based on weapons-grade uranium may be slightly less advanced with a larger diameter, making it difficult to mount them on a Nodong MRBM. However, that objective can be accomplished relatively quickly through continued design work and does not require further nuclear testing.

Since predicting the growth of the North's nuclear stockpile is a difficult task, the project has devised three scenarios based on different technical, political and other assumptions. These projections indicate that North Korea's nuclear stockpile could expand at a rate of anywhere from 100 percent in the best case scenario to 525 percent in the worst case scenario by 2020. The three scenarios are:

1. ***Minimal Growth, Minimal Modernization:*** North Korea's stockpile grows slowly and technological improvements are minimal. The stockpile increases from a current low level of 10 weapons to 20 weapons by 2020. Further miniaturization is also minimal and yields of the weapons remain essentially 10 kilotons, the same as in the baseline stockpile.
2. ***Moderate Growth, Moderate Improvement:*** A continuation of North Korea's current trajectory. In this scenario Pyongyang's stockpile grows from current levels to 50 weapons by 2020, an increase of 212.5 percent. Further advances in miniaturization enable the North to mount warheads on a new generation of road-mobile intermediate-range ballistic missiles (IRBMs) and intercontinental ballistic missiles (ICBMs) as well as shorter-range ballistic missiles (SRBMs). Yields of existing weapons increase to the 10-20 kiloton range while new designs using both plutonium and uranium enter the stockpile and achieve 50 kiloton yields. The North may develop and partially test but not deploy an even more advanced single-stage thermonuclear design.
3. ***Rapid Growth, Rapid Improvement:*** North Korea's nuclear stockpile grows more rapidly than in the previous scenarios to 100 weapons by 2020, an increase of 525 percent. Significant advances are made in weapons designs allowing the North to deploy battlefield and tactical weapons if it chooses to do so. The average stockpile yield increases to 20 or more kilotons with an increasing number having yields of 50 kilotons. A one-stage thermonuclear device with a yield of 100 kilotons is tested but is too large to be deployed. Work is done on developing a two-stage thermonuclear device.

One last scenario seems relevant in predicting the future of North Korea's nuclear stockpile: namely, North Korea could end nuclear testing but continue and perhaps accelerate the production of fissile material. Under this scenario, North Korea's nuclear stockpile could reach as many as the 100 weapons outlined above with very limited qualitative improvements. Nevertheless, given Pyongyang's current technological know-how, such a stockpile would be able to arm selected delivery systems, particularly the Nodong MRBM able to reach targets in South Korea and Japan.

New Delivery Systems Possible if Significant Challenges are Solved

While North Korea's delivery systems are able today to reach most targets in Northeast Asia, particularly in South Korea and Japan, activities over the past five years indicate that Pyongyang has bigger ambitions and is seriously pursuing the development of more capable systems. However, the future of this effort remains more uncertain than in the nuclear program given technological, engineering and other challenges facing Pyongyang.

The backbone of North Korea's current force of 1,000 ballistic missiles is the Nodong MRBM, a mobile, survivable, and reliable missile accurate enough to attack cities, ports and military bases. Supplementing that missile is a large stockpile of SCUD ballistic missiles that can carry a nuclear payload 300-600 kilometers, a newer shorter-range ballistic missile, the KN-02 Toksa, notable because its solid-fuel allows the system to be more survivable and responsive and a small force of light bombers.

Despite its regional focus, Pyongyang may also be able to field a limited number of Taepodong missiles—a militarized version of the Unha space launch vehicle—in an "emergency operational capability" that can reach targets in the United States. These weapons would be highly vulnerable since they would probably be based on an above ground launch pad, have low reliability since only one flight test of the Unha has been successful and would suffer from a lack of testing of reentry vehicles necessary for long-range missiles carrying nuclear warheads. However, it is worth noting that early US missiles were deployed with inaccurate "blunt body reentry vehicles" that did not require flight testing. Overall, while perhaps not an effective operational weapon, deployment of the Taepodong would clearly send a political message to Pyongyang's adversaries but the possibility that the missile might work could not be ignored.

Four key activities from 2009-2014 are important indicators of the North's future objectives for its delivery systems:

1. The development of new road-mobile missiles with greater ranges to signal an intention to withstand preemption, to provide more significant retaliatory options and to target American bases in Guam and the continental United States;
2. A possible effort to develop short-range sea-based missiles that increase survivability, expand the threat to theater targets and complicate defense planning since mobile platforms can attack from any direction;
3. The development of a larger space launch vehicle that could contribute to the further development of longer-range ballistic missiles; and
4. Further development of solid-fuel rocket technology through enhancing the range of the KN-02 SRBM that could yield greater mobility and survivability in future longer-range solid-fuel missiles.

The challenges Pyongyang faces in moving forward with these programs are likely to prove difficult to overcome. Progress will require solving significant technological and engineering problems, particularly since the North is not self-sufficient in missile development and production. Foreign assistance will be essential in acquiring and operationalizing a number of

critical technologies. Nevertheless, it is worth noting that North Korea, like other small nuclear powers, may have a far less demanding definition of success than the United States, which tests missiles extensively before they become operational.

As in the nuclear projections, three scenarios for the development and deployment of delivery systems reflecting different political, economic, technological and other assumptions help bound future possibilities:

1. ***Minimal Modernization:*** Delivery systems remain essentially the same as today with two possible developments. First, North Korea could deploy short-range sea-launched cruise and ballistic missiles on surface ships or submarines. These missiles would be based on existing weapons, possibly the KN-01 naval cruise missile or the KN-02 ballistic missile. Second, Pyongyang could deploy the Musudan IRBM in an emergency operational capability to demonstrate resolve. Despite the fact that the Musudan has not been flight tested by the North, it has already conducted extensive development activities that might allow such a deployment. Indeed, the system may have already been deployed in the field in an emergency during the 2013 crisis on the Korean peninsula if media reports are accurate.
2. ***Steady Modernization:*** North Korea continues its current development and deployment path resulting in an increasing theater threat plus the emergence of an intercontinental threat to the United States by 2020. In the theater, greater numbers of sea-based systems are deployed and Pyongyang may develop an emergency operational capability to field a ballistic missile submarine. Also, in this scenario, the Musudan IRBM becomes an operational system after a limited number of flight tests. With regard to intercontinental developments, the KN-08 ICBM could become available on an emergency basis as it moves towards becoming an operational weapon. One additional possibility is the deployment of Taepodong ICBMs in more survivable hardened missile silos, a technology the North has employed for large radars and surface-to-air missiles since the late 1960s and explored for ballistic missiles since the early 1990s.
3. ***Maximum Modernization:*** North Korea accelerates the development and deployment of new systems, resulting in a growing theater and intercontinental threat that emerges more rapidly than in the previous scenario. In the theater, this will mean greater deployments of the Musudan IRBM, the development of a more survivable, accurate 300 kilometer range solid-fuel missile to replace the SCUD and possibly the deployment of North Korea's first operational ballistic missile submarine. On the intercontinental level, the DPRK would field an operational KN-08 road-mobile ICBM in growing numbers.

An Evolving Nuclear Strategy

Pyongyang's nuclear strategy—its plans for how to use these weapons in wartime and how to communicate its plans in peace time in order to deter opponents—is a work in progress and difficult to predict, particularly given uncertainties about the growth of North Korea's nuclear and missile forces over the next five years. Nevertheless, an examination of the evolution of

North Korean thinking on nuclear weapons, of its defense strategy over the past five decades and specific investments made in its nuclear and missile programs can provide important clues as to the future.

North Korea's evolving nuclear strategy reflects five overriding principles: 1) the maintenance of the Kim family leadership; 2) elimination of all internal threats to the leadership; 3) deterrence of the United States and South Korea; 4) economic development of the nation; and 5) reunification of the Korean peninsula.

Confronted with external security threats—particularly from the United States and its nuclear arsenal—the country's leadership and the Korean People's Army (KPA) devised a strategy that appears to have evolved over time in response to changing external and internal circumstances. Until 1989, before North Korea's nuclear program began to emerge, Pyongyang's strategy was based on the threat of using chemical weapons combined with defensive measures such as the construction of underground facilities to deter and defend against a nuclear attack. That threat was subsequently supplemented by expanding large conventional armed forces and emerging asymmetric capabilities such as special operations forces and ballistic missiles.

As Pyongyang's nuclear program advanced and missile and aircraft delivery systems were acquired the KPA initiated a systematic study of US, Soviet and Chinese nuclear warfare concepts and strategies. By 1989, a rudimentary deterrence strategy may have emerged focused on the political and diplomatic utility of nuclear weapons rather than as tools to fight a conflict. During this period, Kim Il Sung is reported to have first stated that nuclear weapons could not be used on the Korean peninsula due to its small size. Moreover, North Korea's willingness to become a signatory to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) may have reflected the view that these weapons might have limited utility.

Through the 1990s until the early 2000s, a particularly tumultuous period in North Korean history, Pyongyang chose to capitalize on the political and diplomatic utility of nuclear weapons by accepting crippling limits on its plutonium-based fissile material program in return for a better relationship with the United States that would diminish external security threats. However, by the late 1990s, the North probably concluded that its chemical weapons would not deter US nuclear use on the peninsula given Iraq's rapid defeat in the 1990 Gulf War and may have jumpstarted a covert program to enrich uranium. The collapse of efforts to improve relations with the United States in the early 2000s led to the adoption of a new deterrence strategy that probably reflected the KPA's study of other country's approaches and the emergence of an emergency nuclear capability consisting of a handful of weapons. North Korean rhetoric focused on the use of overwhelming artillery, conventional ground forces and ballistic missiles as well as Pyongyang's "right to possess nuclear weapons as a deterrent to the US nuclear threat."

A further evolution of North Korea's strategy, was spurred on by the acceleration of nuclear and missile programs during the last years of Kim Jong Il's rule but also by external events—the 2007 destruction of a North Korean reactor under construction in Syria by an Israeli airstrike and the 2011 US-led attack on Libya eight years after that country gave up its WMD programs. Not only has Pyongyang taken political steps to enshrine the importance of nuclear weapons in ensuring its security, but also other important developments point to the possible elaboration

of requirements for effective deterrence to include credible options for their use in a range of contingencies. These developments include the establishment of a new high-level Strategic Force Command for its missile forces, the development of more survivable weapons systems better able to fulfill deterrence mission, significant strides in the production of more miniaturized weapons and an increasing number of ballistic missile exercises that are applicable to both the use of conventional and nuclear weapons in wartime.

The past five years have also witnessed a new sophistication in the North's articulation of its nuclear weapons strategy for both external and internal audiences, particularly the practical military application of these weapons and their utility in pursuing political priorities. Much of the rhetoric is very similar to US and Russian terminology with nuclear weapons usage characterized in battlefield, operational and strategic terms. However, while these statements on the surface suggest a significant evolutionary step in the North's thinking about deterrence and nuclear strategy, they may also be understood as political rhetoric employed to mimic US statements or an aspirational objective of KPA planners given the small size of the North's nuclear stockpile and limited capabilities of its delivery systems.

All of these developments would seem to indicate that Pyongyang is striving for a policy of deterrence based on a more credible assured retaliation capability. This approach is reflected in North Korea's policy adopted by the Supreme People's Assembly (SPA) in 2013: "[Nuclear weapons] serve the purpose of deterring and repelling the aggression and attack of the enemy against the DPRK and dealing deadly retaliatory blows at the strong holds of aggression…."

The key question for the future is whether Pyongyang has ambitions to establish deterrence based on a strategy beyond assured retaliation that includes options for the limited initial use of nuclear weapons in order to bolster the credibility of deterrence. The SPA "Law on Consolidating Position of Nuclear Weapons State" expands the role of nuclear weapons beyond deterring high-end attacks to also deter and repel lower levels of aggression using its nuclear weapons: "The DPRK shall take practical steps to bolster up the nuclear deterrence and nuclear retaliatory strike power both in quality and quantity to cope with the gravity of the escalating danger of hostile forces' aggression and attack."

Logically, it may make some sense for Pyongyang to move beyond a reliance on assured retaliation to a war-fighting posture that threatens the early use of nuclear weapons to also deter conventional attacks. Just like NATO was confronted by the Soviet Union during the Cold War and Pakistan faces a superior India today, Pyongyang is confronted by more capable American and South Korean conventional forces.

However, if the North evolves in this direction, it will have to address a number of difficult issues, particularly the reality that such a strategy would require integration of nuclear weapons into its broader military doctrine and a much more sophisticated command and control system including some pre-delegated authority to commanders to use those weapons. On the first count, there are some signs that Pyongyang is considering such integration. But on the second, at least as of today, launch authority remains highly centralized as might be expected in a regime like

North Korea. Whether this will change in the future remains unclear. While change would appear unlikely, making predictions is difficult, in part because Kim Jong Un's leadership style is still evolving.

Aside from technological challenges, an additional factor to consider in predicting the future of Pyongyang's nuclear strategy could be unique national circumstances. North Koreans often argue that military hardware has to be adapted to Korean circumstances and realities, an argument that may also apply to nuclear weapons and seems particularly relevant given Kim Il Sung's past skepticism about the use of these weapons. To the extent Pyongyang's war plans are based on the expectation of actually winning and inheriting South Korea's wealth, avoiding widespread or indiscriminate and unnecessary damage would seem to be very important, once again driving the North in this direction. However, even in the context of building a force of more accurate, lower yield nuclear weapons, there may be a significant political/psychological barrier to their use by North Korean leaders on the peninsula, namely, they would be used against their own people.

In this context, Pyongyang would probably have no such hesitation in using nuclear weapons against Japan in a war on the peninsula. It would not be hard to imagine that if the tide turned against the North, in part because of Japan's role in assisting the US and South Korea, that Pyongyang could use these weapons against civilian and military targets in that country.

Given the development of North Korea's deterrence strategy over time, its most recent manifestations and the possible technical, political and other challenges facing Pyongyang in formulating a future approach, how might North Korea's nuclear strategy evolve under the three scenarios postulated out in this paper?

- ***Low-end Scenario:*** A North Korea armed with 20 nuclear weapons and only minor improvements to its current force of delivery systems seems likely to continue to rely on a policy of assured retaliation, threatening the use of these weapons in response to a nuclear attack by the United States. In that context, if necessary, their use against targets in South Korea will be allowed only under extreme conditions. The threshold for use against targets in Japan will be lower.
- ***Medium Scenario:*** With a nuclear deterrent of 50 nuclear weapons, a growing range of yield, additional mobile theater-range delivery systems possibly including greater numbers based at sea, and an emerging intercontinental force, Pyongyang will possess a more survivable and robust assured retaliatory capability perhaps able to credibly threaten the United States. Pyongyang's greater assured retaliatory capability may allow the development of more limited options for the use of these weapons against theater targets, particularly in Japan. Still, the limitations against using these weapons on the peninsula will remain significant.
- ***High-end Scenario:*** A North Korea armed with 100 low, medium and high-yield nuclear weapons that can be mounted on an array of battlefield, theater and intercontinental delivery systems would certainly have an even more survivable robust assured retaliatory capability. In addition, because of the size of the force as well as its variety of delivery systems and nuclear devices, the North could consider a further evolution in its nuclear strategy beyond assured retaliation to allow for threatening "first use," but only under

certain conditions. In that context, "battlefield" nuclear weapons would be integrated into Pyongyang's war plans and the limited use of these weapons on the peninsula would be provided for under certain conditions. The threshold for use against Japan would be lowered as well.

Is North Korea's Nuclear Future a Game Changer?

While the North Korea's Nuclear Futures Project plans to address the implications of and policy responses to these developments in detail in the future, the results of this workshop raises disturbing questions:

- On the US geopolitical position in Asia, will an increasing North Korean WMD challenge result in a decreasing ability by the United States to successfully rebalance and manage its alliances?
- On the military strategy to defend the Republic of Korea, as DPRK force survivability and its options for the possible use of nuclear weapons increase, will our ability to prevent the North from crossing the nuclear threshold in a conflict decrease?
- On non-proliferation, as the North Korean arsenal grows and the danger of nuclear/missile exports increases, will our ability to prevent this from happening or to punish Pyongyang decrease?
- Finally, on North Korean foreign policy, as its WMD capabilities grow, will Pyongyang's external behavior become more assertive while our ability to counter that behavior decreases?

One final critical issue that these developments raise is the answer to the question "who is winning the battle of alternative paths between the United States and North Korea?"

For two decades, American presidents have presented a choice to North Korea between giving up its nuclear weapons program and establishing better ties with the international community, leading to economic prosperity, or isolation and self-implosion.

Today, Kim Jong Un is increasingly offering his own choice between accommodation and acceptance of a nuclear-armed North Korea or periodic tensions and instability on the peninsula. This offer is built on the foundation of a nuclear and missile capability that is poised to rapidly expand over the next five years.

The answer to this question remains entirely unclear but will determine the future shape of Northeast Asia for many years to come.

TECHNOLOGY AND STRATEGY

Introduction

Since the end of the Korean War, the United States has grappled with the security challenge posed by the Democratic People's Republic of Korea. An increasingly important component of that challenge has been North Korea's pursuit of nuclear weapons and delivery systems. Pyongyang's quest has stretched out over decades, representing an enormous investment of manpower, resources and money totaling billions of dollars.

While the international community is generally aware of Pyongyang's programs, largely through the North's sporadic conduct of nuclear weapons and long-range rocket tests, little recent attention has been focused on the very significant dangers posed by this effort. The international community and media are focused on heading off Iran's small nuclear weapons program rather than on the disturbing developments on the Korean peninsula. Another reason for the lack of serious attention is the still prevailing view of North Korea as a starving, backwards and isolated country led by a young inexperienced and somewhat comical dictator. That perception was, to some degree, offset by the recent North Korean cyber-attack on Sony Pictures.

The North Korea's Nuclear Futures Project,[1] conducted by the US-Korea Institute at the Johns Hopkins School of Advanced International Studies in cooperation with the National Defense University Center for the Study of Weapons of Mass Destruction, was established in mid-2014 to examine Pyongyang's emergence as a small nuclear power. The project, through a series of three workshops in 2014-2015, will analyze how North Korea's nuclear deterrent and strategy may develop over the next five years, the implications for the United States, the region and the international community and possible policy responses.

The first of three workshops, held in October 2014 was attended by a distinguished group of American experts on weapons technology, North Korea, US nuclear weapons and strategy as well as on the experiences of other small nuclear powers such as Israel, Pakistan, India and

[1] This publication results from research supported by the Naval Postgraduate School's Project on Advanced Systems and Concepts for Countering Weapons of Mass Destruction (PASCC) via Assistance Grant/Agreement No. N00244-14-1-0024 awarded by the NAVSUP Fleet Logistics Center San Diego (NAVSUP FLC San Diego). The views expressed in written materials or publications, and/or made by speakers, moderators, and presenters, do not necessarily reflect the official policies of the Naval Postgraduate School nor does mention of trade names, commercial practices, or organizations imply endorsement by the US Government. This North Korea's Nuclear Futures Series was also made possible by support from the John D. and Catherine T. MacArthur Foundation.

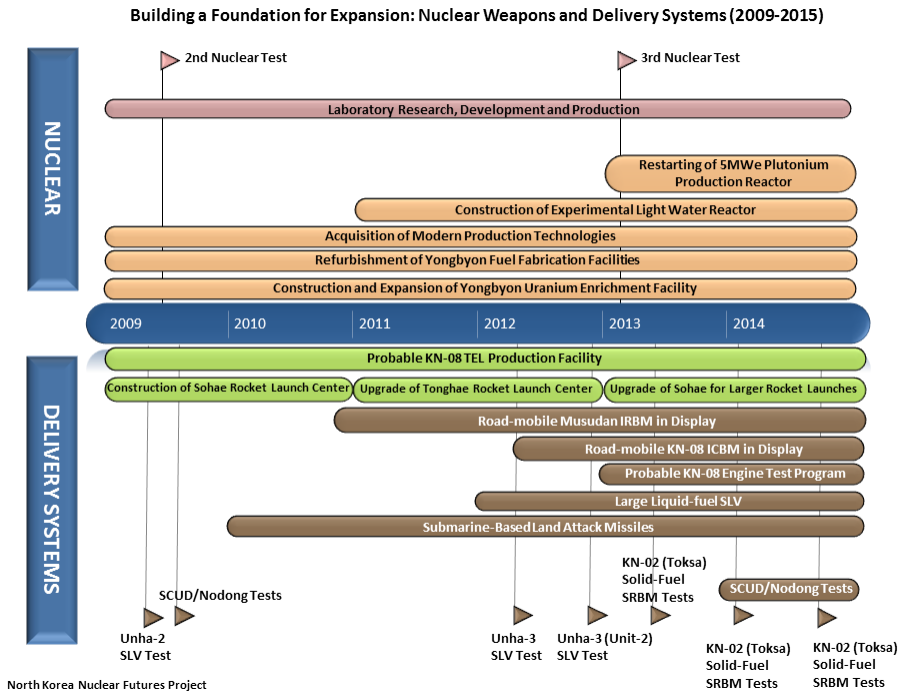
China. The meeting analyzed North Korea's WMD technology and its emerging nuclear strategy, looking at where it might be headed by 2020. Given the uncertainties involved in forecasting the future, the workshop developed a range of possible scenarios over the next five years.[2]

North Korea's WMD Programs: Poised for Expansion

Building on a decades-long effort and recent large-scale investments since the collapse of the 1994 US-North Korea Agreed Framework in 2002, Pyongyang's nuclear and missile programs have gathered significant momentum. While predicting North Korea's future course of action is always difficult, these programs now appear poised to rapidly expand over the next five years, presenting a serious challenge to the United States, Northeast Asia and the international community.

That expansion will benefit from a long list of accomplishments achieved between 2009 and 2015, banner years for Pyongyang's nuclear and missile programs (figure 1). Aside from the most obvious manifestations of this effort—North Korea's second and third nuclear detonations in 2009 and 2013 and two long-range rocket tests in 2012—Pyongyang has been conducting other important activities on both fronts. Building on its two nuclear tests, the North has probably made further advances in the development of nuclear weapons. At the same time, Pyongyang has modernized and expanded its fissile material production infrastructure and continued a concerted effort to procure technology abroad, particularly for its uranium enrichment program.

Figure 1. Building a Foundation for Expansion: Nuclear Weapons and Delivery Systems (2009-2015).



[2] This summary is based on workshop papers authored by David Albright, John Schilling, Joseph Bermudez and Shane Smith that formed the basis for discussion and comment by other experts at the meeting. The project would also like to thank Olli Heinonen, Michael Elleman and Robert Carlin for their contributions to its work.

Significant advances were also made in the development of missile delivery systems, including: 1) the appearance of two new road-mobile rockets; 2) a large number of missile tests including three launches of space launch vehicles as well as existing medium-range missiles, and an extended-range solid-fuel short-range ballistic missile; 3) the possible development of new sea-based land-attack missiles—cruise or ballistic—as well as what may be a class of submarine designed to handle such systems; 4) the development of a rocket significantly larger than the Unha space launch vehicle (SLV) that may have military applications; and 5) the modernization of Pyongyang's development, testing and production infrastructure.

These activities could just be the tip of the iceberg. Public information on North Korea's nuclear and missile activities is less than is available to the US and other governments. That information, in turn, probably does not provide a full picture either, since Pyongyang tries to cloak its effort in secrecy. The scope of activity, however, is no guarantee that these programs will result in the deployment of more and newer weapons. Indeed, the history of these kinds of programs in other countries is one of periodic failures due to a host of problems—political, technical, economic and bureaucratic. Nevertheless, North Korea's activities are disturbing indicators of a vibrant and extensive effort to build a larger nuclear arsenal and more capable missile delivery systems.

Impending Rapid Growth of the Nuclear Weapons Stockpile

North Korea's current nuclear stockpile is estimated at 10-16 weapons including 6-8 devices fashioned from plutonium and 4-8 from weapons-grade uranium. This range reflects uncertainty, at least in terms of publicly available information, in the number of plants producing weapons-grade uranium, of centrifuges deployed successfully and how well these centrifuges have operated.[3]

As for the nuclear designs themselves, North Korea has likely achieved a level of sophistication sufficient to allow Pyongyang to mount warheads on its main regional delivery system, the Nodong MRBM, which is able to reach targets in South Korea and Japan. The North's effort to develop such a warhead began in the mid-1980s and has stretched on for almost 30 years. Pyongyang may have also received other helpful nuclear designs from the smuggling network run by A.Q. Khan in the 1990s or earlier from China, as Pakistan did in the early 1980s. Moreover, given the likely dimensions of the North Korean warhead, it can probably also be mounted on other missiles, particularly a Taepodong ICBM, a militarized version of the North's Unha space launch vehicle.

[3] In the first scenario, North Korea operates two production-scale plants, the first starting production sometime between 2005 and 2010. The first plant is assumed to have produced weapons-grade uranium and to contain 2,000-3,000 P2-type centrifuges. The second plant at Yongbyon is assumed to contain at least 2,000 P2-type centrifuges and have made only low-enriched uranium (LEU) for reactor fuel through 2014, perhaps to avoid detection by international inspectors in case of a negotiated shutdown. In this scenario, 15-16 weapons are produced by the end of 2014. In scenario two, North Korea has only one production-scale plant that started operating in 2010. Through 2011, the plant produced LEU for the North's light water reactor and for the next three years, weapons-grade uranium. This scenario corresponds to North Korean public statements about its centrifuge program. The plant is assumed to have started operations with 2,000 P2-type centrifuges with additional machines becoming operational by the end of 2014, possibly as a result of the recent expansion of the Yongbyon plant. In this scenario, 10-11 weapons were produced by the end 2014.

As for warheads based on weapons-grade uranium, that effort may lag slightly behind the development of plutonium-based designs. Such weapons would require larger amounts of fissile material and have a larger diameter. While it is not likely that a North Korean fission device using WGU could be mounted on a Nodong missile today, Pyongyang will probably develop such a warhead in the near-future based on existing knowledge. It will not require further nuclear tests to accomplish this objective.

Building on activities conducted over the past five years, North Korea's nuclear weapons stockpile appears ready to grow rapidly and to achieve important qualitative improvements by 2020.[4] How rapidly its arsenal expands and what level of improvements Pyongyang achieves will depend on three critical factors: 1) the level of political and economic commitment by the North Korean leadership; 2) Pyongyang's ability to achieve further technological advances largely, but not entirely dependent, on the conduct of nuclear tests; and 3) the success of the North's efforts to secure foreign assistance—the illicit procurement of technology, the level of nuclear cooperation with other countries such as Iran and the acquisition abroad of nuclear weapons data and new designs.

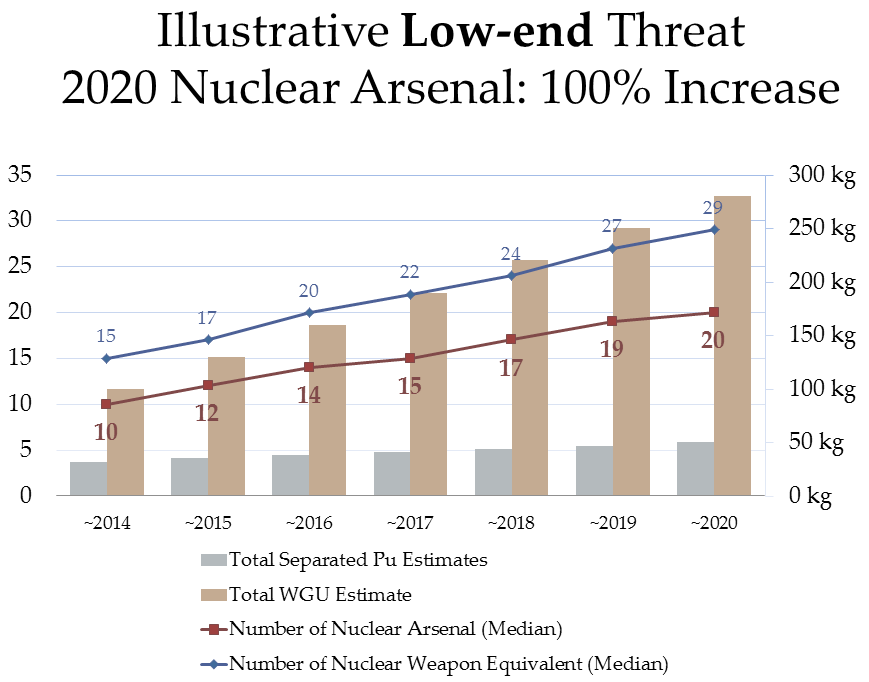
Three scenarios have been formulated to project the size and sophistication of North Korea's nuclear stockpile taking into account these factors. While these scenarios are by no means all the possible paths of development for North Korea's nuclear weapons program, by laying out what may be the best and worst case analyses, they capture a band that has a greater chance of predicting the future than focusing on any one probable outcome. Moreover, the scenarios also provide a roadmap for what qualitative improvements might be possible under different circumstances.

Scenario 1: Minimal Growth, Minimal Improvement

Under this scenario, North Korea's nuclear arsenal grows slowly and technological improvements are minimal. The stockpile increases 100 percent from a low current level of 10 weapons to 20 weapons by 2020 (figure 2). The yields of these weapons remain essentially the same—10 kilotons—as in the baseline stockpile. Further miniaturization is minimal, largely through honing existing nuclear weapons design skills, without sacrificing yields. The number of designs remains small, suitable only for a few delivery systems, mainly the Nodong MRBM and a Taepodong-2 ICBM. No reductions are achieved in the amount of fissile material necessary for each weapon. Improvements in safety, security and reliability will also be minimal.

[4] Overall DPRK objectives appear to include: 1) increase the size of its stockpile; 2) increase the explosive yield of weapons, including developing advanced weapons designs; 3) additional miniaturization without sacrificing yield; 4) reduce the amount of nuclear material in each weapon; 5) increase safety, security and reliability; and 6) greater self-sufficiency in the production of weapons.

Figure 2. Illustrative Low-end Threat, 2020 Nuclear Arsenal.



This scenario assumes: 1) a low level of fissile material production based on a restarted 5 megawatt-electric (5 MWe) plutonium production reactor at Yongbyon experiencing periodic operating difficulties as well as one plant producing weapons-grade uranium with only 3,000-4,000 operating centrifuges; 2) no further nuclear tests, possibly because of pressure from China; 3) difficulties in acquiring foreign technology—such as vacuum equipment, pumps, sophisticated computer numerical controlled (CNC) machine tools and specialized chemicals and metals—that further reduce the efficiency of fissile material production; and 4) nuclear weapons related information acquired abroad is minimal and cooperation with other countries—including Iran—achieves few results.

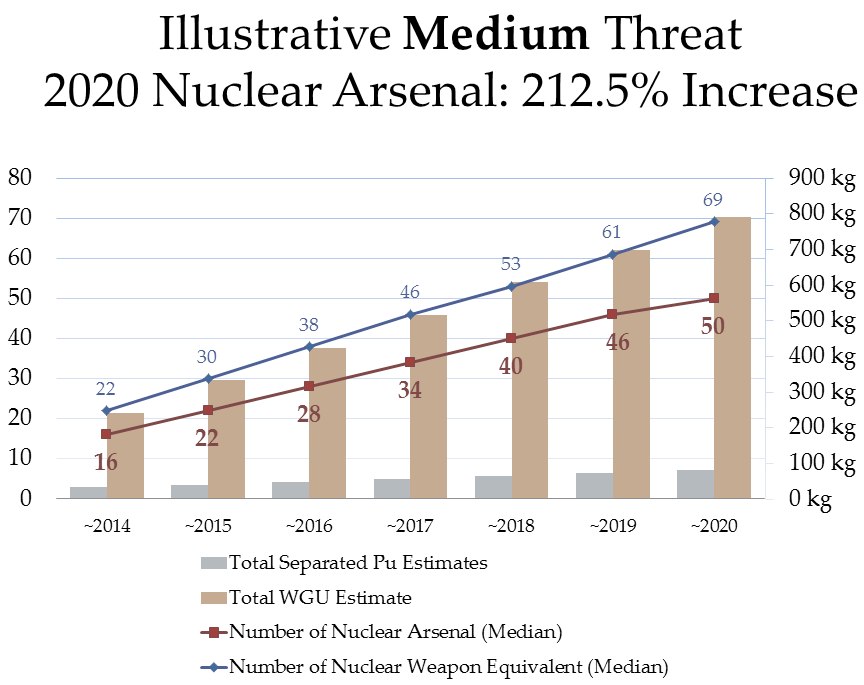
The slow growth scenario may be the result of a number of underlying factors. For example, the level of political and economic commitment to the program by North Korea's leadership could diminish either because of a decision that 20 weapons is a sufficient number to defend the country or because of deepening problems in the civilian economic sphere that limit resources available for these programs.

Scenario 2: Moderate Growth, Moderate Improvement

Continuing the current trajectory, North Korea's stockpile grows from 16 weapons to 50, an increase of 212.5 percent (figure 3). Modest qualitative improvements are achieved. Advances in miniaturization enable the North to mount warheads on a new generation of road-mobile IRBMs and ICBMs as well as short-range ballistic missiles. Continued nuclear testing and advances in design skills enable the North to increase the yields of existing designs to 10-20 kilotons on average. Moreover, Pyongyang develops and deploys a weapons design that contains plutonium

and weapons-grade uranium in the same core, allowing a significant increase in explosive yield up to 50 kilotons. In addition, the North may develop an even more advanced single stage thermonuclear design—not fully tested or deployed—that utilizes tritium, deuterium and lithium within a composite core of plutonium and WGU.

Figure 3. Illustrative Medium Threat, 2020 Nuclear Arsenal.



In this scenario, North Korea's fissile material production base is larger, consisting of the 5 MWe reactor operating more efficiently and partial use of an operating small light water reactor for producing plutonium as well as 6,000-7,000 operating centrifuges in two plants producing WGU. The centrifuges operate at poor efficiency but better than in the low-end projection. Moreover, Pyongyang develops a centrifuge similar to the Pakistani P3-type that can double the output of its existing model when eventually deployed. A final assumption is that the North conducts a nuclear test every 3-4 years, just as it has since 2006, as part of an active development program.

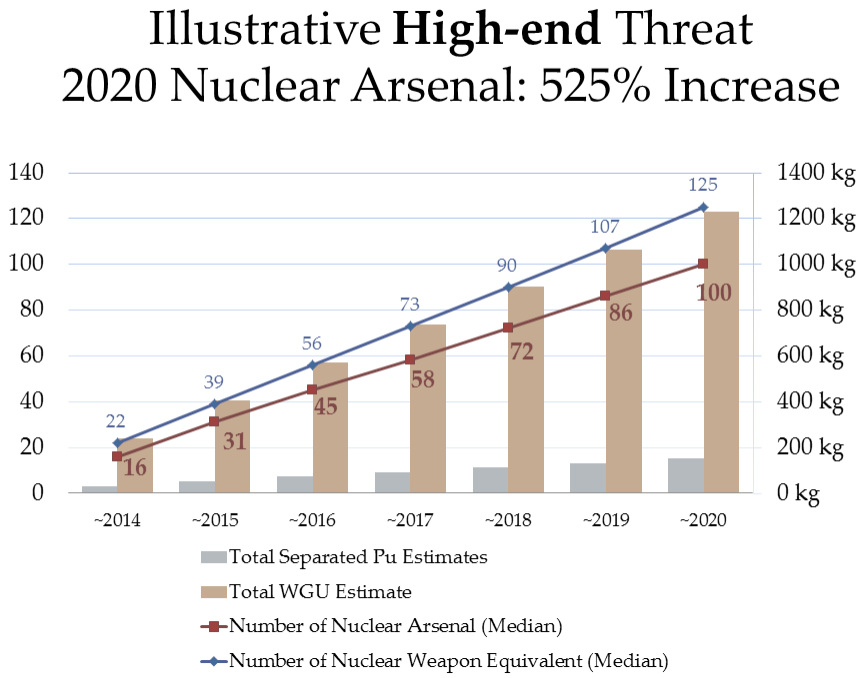
The North Korean leadership stays the course in its political and economic commitment to the development of a nuclear deterrent. Mixed success is achieved in securing foreign technology (but better than in the low-end scenario) resulting in progress in making key materials and equipment domestically. Some benefits may also come from limited nuclear cooperation with Iran that will aid Pyongyang's centrifuge program and procurement efforts.

Scenario 3: Rapid Growth, Rapid Improvement

North Korea's nuclear stockpile grows more rapidly than in the two previous scenarios, to 100 weapons by 2020, an increase of 525 percent (figure 4). Significant advances are made in nuclear weapons design. Further miniaturization allows the DPRK to deploy battlefield and

small tactical nuclear weapons if it should chose to do so. The average yield of weapons in the North's stockpile with either uranium or plutonium cores increases to 20 or more kilotons while an increasing number of composite core devices with yields of 50 kilotons are deployed. A one-stage 100 kiloton thermonuclear device is tested but is too large to become operational. Work is conducted on designing and developing a two-stage thermonuclear device.

Figure 4. Illustrative High-end Threat, 2020 Nuclear Arsenal.



The rapid growth and qualitative improvement of the nuclear stockpile in this scenario is the result of: 1) a plutonium production base consisting of the 5 MWe reactor consistently operating at full power and a fully militarized small light water reactor available as of 2016, two years earlier than in the previous projection; 2) two operating uranium enrichment plants with greater numbers of centrifuges—8,000-9,000—including 2,000 of the more modern P3-type design; 3) an increased nuclear test rate of one detonation per year; 4) successful overseas procurement facilitating greater indigenous production of key equipment and materials facilitating even further development of indigenous capabilities; and 5) the acquisition of nuclear weapons data and an advanced design abroad allowing the North to speed up weapons development.

This scenario assumes that the North Korean leadership steps up its political and economic commitment to its nuclear program, perhaps as a result of an increasingly threatening external security environment. A commitment of more resources to the program may also be the result of an improving civilian economy or even cutbacks in conventional military expenditures.

One Last Scenario: Rapid Growth without Testing

One last scenario is worth nothing, namely that North Korea could end nuclear testing but continue and perhaps accelerate its production of fissile material. Under this scenario, Pyongyang's nuclear weapons stockpile could continue to grow to as many as 100 weapons with very limited qualitative improvements. Moreover, despite its technological limits, given the assessment of Pyongyang's current level of miniaturization, such a stockpile would be able to arm a large number of selected delivery systems in the North's inventory, particularly the Nodong MRBM able to reach South Korea and Japan.

New Delivery Systems Possible if Significant Challenges are Solved

While North Korea's nuclear delivery systems are capable and able to reach most potential targets in the region, activities over the past five years indicate that Pyongyang has bigger ambitions and is seriously pursuing the deployment of more capable weapons. However, the future of these systems remains more uncertain than in the nuclear program, particularly in view of important engineering and other challenges facing Pyongyang.

North Korea's current force, consisting largely of an array of 1,000 ballistic missiles based on decades-old Soviet technology, remains limited but capable. The backbone of that force, the Nodong MRBM, is mobile, survivable, reliable and accurate enough to strike cities, ports and military bases. Supplementing the Nodong is a large stockpile of SCUD missiles able to carry a nuclear payload 300-600 kilometers as well as a newer mobile SRBM, the KN-02 Toksa, notable because its solid fuel allows the system to be more survivable and responsive. Overall, Pyongyang's current inventory appears more than large enough to accommodate even the rapid expansion of the North's nuclear stockpile to a level of 100 weapons.

In addition, North Korea may also be able to deploy a limited number of Taepodong-2 ICBMs, essentially a militarized version of the Unha SLV in an "emergency operational capability," intended to at least threaten the possibility of striking targets in the United States. The Taepodong, however, would suffer from potential problems not unlike early US and Soviet ICBMs deployed in the 1950s including: 1) low reliability given the limited number of flight tests and high percentage of failures (three out of four launches) of its SLV counterpart; 2) vulnerability to preemptive attack since the missile would probably be deployed on an above ground launch pad; and 3) the lack of testing of reentry vehicles necessary for long-range missiles carrying nuclear weapons, although it is worth noting that early US missiles were deployed with inaccurate but functioning "blunt body reentry vehicles" that did not require flight testing.

Four activities from 2009 until 2014 provide important clues as to the North's future objectives:

1. The appearance of more modern road-mobile ballistic missiles with greater ranges—the Musudan IRBM and KN-08 ICBM—signal an intention to withstand preemption, to provide the leadership with more significant retaliatory response options and to strike American bases on Guam and targets in the continental United States.

2. What appears to be an effort to develop sea-launch, land-attack missiles—cruise or ballistic—on surface ships or submarines that would increase survivability and expand the threat to theater targets, particularly Guam, as well as complicate missile defense planning since mobile platforms can strike from any direction.
3. Pyongyang's plan to build a larger SLV could contribute to further development of long-range missiles through the testing of common technologies such as high-energy rocket engines, guidance system components and even reentry vehicles (in sub-orbital modes).
4. The North's program to extend the range of the solid-fuel KN-02 Toksa SRBM may signal an intention to further develop this technology for future use since it has greater stability over long periods of storage. As a result, solid-fueled rockets are more easily transportable and have greater survivability since they can be launched more quickly than liquid-fueled rockets.

The challenges North Korea faces in moving forward with these programs and in accomplishing its objectives are likely to prove difficult but not impossible to surmount. These programs may be subject to unforeseen internal political, economic or other hurdles that could result in either slowing development or even cancelation. That has certainly happened in other countries embarking on the development of similar technologically challenging missile systems.[5]

Progress will also require overcoming technological and engineering hurdles that are even more significant than in the production of nuclear weapons. In this context, since the North is not self-sufficient in missile production, the level of foreign assistance—both technology and experienced engineers—could be a critical factor determining how much progress Pyongyang is able to make in the future in critical technologies such as high-performance liquid-fuel engines, solid-fuel rocket motors, high-speed heat shields and reentry vehicles, guidance electronics, sophisticated machine tools and high-strength, lightweight materials.

Nevertheless, North Korea may have a far less demanding definition of "success" in the development of new missiles than the United States, whose delivery systems are extensively tested before becoming operational to ensure a high degree of reliability and predictability. Other small emerging nuclear powers have had the same view of new missile delivery systems, deploying systems with very few flight tests. This practice highlights another important consideration for Pyongyang (and these other countries), namely that deployments of new delivery systems, even if not fully tested, can have an important political purpose in sending deterrence signals to potential adversaries.

Bounding the Problem: Three Deployment Scenarios for 2020

In view of uncertainties in predicting the future, postulating three scenarios that take into consideration the baseline force, technical objectives and critical determining factors will at least provide an illustrative band of possibilities within which a future North Korean delivery force is more likely to fall. It also highlights the steps that may be necessary to field new weapons.

[5] For example, Iran's program to build a 2,000 kilometer-range solid-fuel missile seemed to be on track for deployment in 2012 but appears to have stalled for reasons other than meeting technical challenges.

Moreover, on the assumption that the DPRK's program will bear some relationship to plans for its nuclear stockpile, combining projections also bounds what the North's overall future force posture may look like in 2020:

1. ***Minimal Modernization:*** North Korean delivery systems remain essentially the same as today, posing a political threat to the United States but focused largely on targets in neighboring countries. This lack of progress reflects: 1) a limited test program (no tests of long-range rockets and only of existing medium or shorter-range systems); 2) significant constraints on the acquisition of foreign technology and assistance, including from Iran; and 3) a high level of political commitment but technical challenges still cannot be overcome or, alternatively, commitment may decrease if the North decides its current force is sufficient and the cost of improvement is too great.

   There are two possible new developments in this scenario. First, North Korea could deploy short-range sea-launched ballistic and cruise missiles. This threat could include merchant ships carrying either type of weapon or the first operational submarine-launched cruise missile.[6] Given the technological challenges in developing such a capability, these weapons would be based on existing North Korean systems, for example, the 160-kilometer KN-01 naval cruise missile or the KN-02 SRBM. A second new development might be deployments of the road-mobile Musudan IRBM in an "emergency operational status" by 2020 despite the lack of full-scale flight tests. The North has already conducted extensive development activities for this missile that might enable such a deployment over the next five years if not sooner. Indeed, as tensions mounted on the Korean peninsula in early 2013, the media reported that the Musudan had been spotted in the field, perhaps in preparation for a flight test. While a test never took place, if the reports were accurate, the deployment may have been intended to demonstrate North Korea's resolve.

2. ***Steady Modernization:*** In this scenario, North Korea continues down its current development path including a test program of 2-3 long-range rocket launches every three years as well as tests of theater systems including the Musudan IRBM. Pyongyang is moderately successful in acquiring foreign technology and assistance despite export controls and sanctions while cooperation with Iran starts to yield benefits in developing solid-fuel technology. A high level of political and economic commitment to these programs by the leadership continues.

   As a result, the theater-level threat becomes even greater than in the first scenario and an operational intercontinental threat begins to emerge. In the theater, in addition to possibly deploying more land-attack cruise missiles on submarines and surface ships as well as ballistic missiles on surface vessels, Pyongyang may develop an emergency operational capability to launch short-range ballistic missiles from submarines. On land, the Musudan IRBM becomes operational after flight testing. On the intercontinental level, Pyongyang

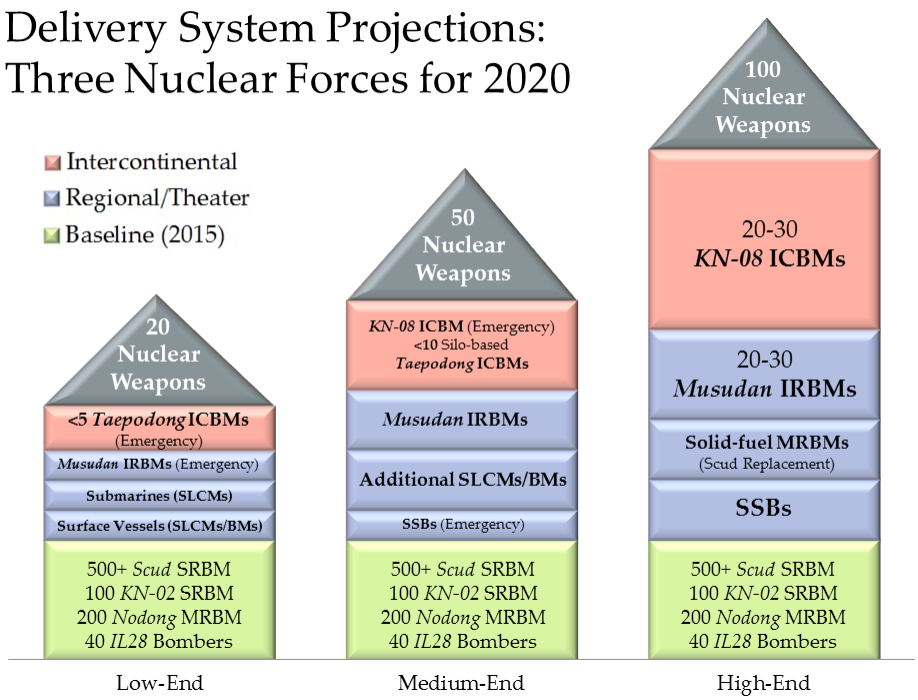
[6] The United States and the Soviet Union explored the possibility of basing on merchant ships during the early years of the Cold War. Iran has demonstrated this capability and North Korea is believed to have studied this option in the past. Recent commercial satellite imagery, ROK government statements and press reports seem to confirm an active effort by the North in this area, although that is certainly no guarantee that their program will produce operational results.

might consider limited permanent deployments of the Taepodong in hardened silos.[7] Finally, an accelerated effort to field the KN-08, including flight-testing, may allow the North to field that system for in an emergency operational status intended mainly for political demonstrations.

3. ***Maximum Modernization:*** North Korea accelerates the deployment of theater and intercontinental delivery systems and begins to explore fielding even more advanced weapons. Pyongyang pursues an aggressive flight-test program with 3-4 launches per year of long-range rockets. Reinforcing these stepped up development programs, the North is successful in securing hardware and assistance overseas as well as important assistance from governments such as Iran. It may also secure the help of foreign experts. Finally, the level of political and economic commitment to these programs increases, perhaps because of an increased security requirement or successful civilian economic development frees resources that can be channeled into these programs.

   As a result, a growing theater and intercontinental threat emerges more rapidly. In the theater, this may mean greater numbers of the Musudan IRBM are deployed, a more survivable, accurate solid-fuel 300-kilometer range missile is developed to replace the SCUD and possibly the DPRK's first operational ballistic missile submarine is fielded.[8] On the intercontinental level, the DPRK would begin to deploy growing numbers of the road-mobile KN-08 ICBM.

Figure 5. Delivery System Projections: Three Nuclear Forces for 2020.



[7] Aside from extensive experience in building silos for surface-to-air missiles dating back to the 1970s, Pyongyang has also explored basing ballistic missiles in silos since at least the early 1990s. Moreover, North Korean scientific literature demonstrates an understanding of the technical challenges involved in building such silos.

[8] Such a development would probably require foreign assistance from countries or individuals with experience in building ballistic missile submarines.

An Evolving Nuclear Strategy

Pyongyang's nuclear strategy—its plans for how to use these weapons in wartime and to communicate those plans in peacetime to deter potential opponents—is also a work in progress. Therefore, predicting Pyongyang's strategy in 2020 is difficult given a number of uncertainties, not the least of which is the level of development its nuclear and missile capabilities will reach in the next five years. Nevertheless, an examination of the evolution of North Korean thinking about nuclear weapons, of its defense strategy over the past five decades and specific investments made in its nuclear and missile programs can provide important clues as to the future.

The development of a nuclear strategy in North Korea reflects five overriding principles: 1) the maintenance of the Kim family leadership; 2) deterrence of the United States and South Korea; 3) elimination of all internal threats; 4) economic development of the nation; and 5) reunification of the Korean peninsula.

In that context, as North Korea's nuclear program has evolved, the country's leadership and the Korean People's Army gradually developed a strategy that appears to have progressed in stages, from viewing these weapons as primarily political tools to deter attack, to a strategy focused on defense intended to inflict unacceptable losses upon attacking forces, to an approach that possibly views nuclear weapons in the context of a range of strategic, operational and "battlefield" (i.e. tactical) wartime uses. Specifically, Pyongyang's views on nuclear weapons can be divided into five historical periods:

1. ***Fatherland Liberation War and Reconstruction (1950-1960):*** Recognition of the potential destructiveness of nuclear weapons and the almost total lack of defense against them was significantly reinforced when the US threatened to employ these weapons to end the war. These threats had a profound effect on the North Korean leadership and have pervaded its thought and actions ever since. Pyongyang established a strategy to address what was then called "ABC" (Atomic, Biological and Chemical) weapons by starting its own nuclear research programs—necessary to build the skills for eventually developing its own weapons—and reestablishing chemical defense units also responsible for preparations against nuclear attack.
2. ***Substituting Chemical Weapons for a Nuclear Deterrent (1960-1976):*** During this period, the institutionalization of limited but practical defensive nuclear warfare capabilities in response to continued concerns about the US nuclear weapons threat was achieved. It appears that Kim Il Sung and the North Korean leadership believed that Pyongyang's acquisition of chemical weapons as substitutes for nuclear weapons in combination with the KPA's growing conventional forces, could deter US nuclear weapons use. Moreover, Pyongyang established a program for the construction of underground facilities and emphasized operations on the chemical and nuclear battlefield in training.
3. ***Nuclear Weapons as Political/Diplomatic Symbols (1976-1989):*** As Pyongyang's nuclear development program advanced and missile and aircraft delivery systems were acquired, the KPA initiated a systematic study of US, Soviet and Chinese nuclear warfare concepts and strategies. By 1989, a rudimentary deterrence strategy had been developed

focused on the political and diplomatic utility of nuclear weapons rather than as tools to fight a war. The view appears to be supported by Kim Il Sung's reported pronouncement during this period that nuclear weapons could not be used on the Korean peninsula due to its small size. In the minds of the North Korean leadership, the correctness of pursuing nuclear weapons as tools to enable room for political maneuvering was likely reinforced by the international political pressure brought to bear to compel them to sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1985. Until the time when nuclear weapons would become available, it appears that the North Korean leadership viewed chemical weapons and expanding conventional armed forces, combined with emerging asymmetric capabilities, as the primary means of deterring the threat of US nuclear weapons.

4. ***Strategy Refined (1989-early 2000s):*** This period was the most tumultuous in the existence of North Korea since the Korean War, including the collapse of its Soviet ally, China's rapprochement with South Korea, the rapid US victory over Iraq in Operations Desert Storm/Desert Shield, the death of Kim Il Sung and a deteriorating economy as well as widespread famine. Under these circumstances, the North sought to capitalize on the political and diplomatic utility of nuclear weapons by accepting significant limits on its fissile material production program in return for better relations with the United States. Nuclear research and development programs continued as did the development of ballistic missiles, although longer-range weapons were subject to an agreed test moratorium with the United States.

   By the late-1990s, however, Pyongyang probably realized that Iraq's chemical weapons did not hinder the US from soundly defeating that nation and that those weapons would not deter US nuclear use on the peninsula. Moreover, the North seems to have jump-started a uranium enrichment program that could eventually produce weapons-grade material. The adoption of a deterrence strategy, based on the KPA's study of other country's nuclear strategies as well as the Iraq experience, emerged in the early 2000s, after the collapse of the 1994 Agreed Framework when the North may have achieved an emergency nuclear capability based on a handful of weapons and ballistic missile delivery systems. Evolving views of nuclear warfare and strategy were reflected in North Korean rhetoric about the use of overwhelming artillery, conventional ground forces and ballistic missiles as well as Pyongyang's "right" to possess nuclear weapons as a deterrent to the US nuclear threat.[9]

5. ***Assured Retaliation Emerges (Early 2000s-2014):*** North Korea's development of a nuclear force and strategy to deter the United States and to ensure regime survival continued during the years leading up to King Jong Il's death and afterwards. Two events—Libya relinquishing up its WMD programs under pressure from the United States, followed by the March 2011 US attack on that country and the 2007 Israeli airstrike destroying the North Korean reactor under construction in Syria—reinforced Pyongyang's view that neither event would have occurred had those nations possessed nuclear weapons. Indeed, key nuclear and missile programs accelerated under Kim Jong

[9] An example of this was a 2002 Foreign Ministry statement declaring that North Korea is "…entitled to have nuclear weapons and more [powerful weapons] than those to safeguard our sovereignty and right to survive in response to the increasing US threat of crushing us with nuclear [weapons]."

Il and became more visible at the end of his life. Since his death, Pyongyang under Kim Jong Un's leadership has also taken political steps to emphasize the importance of nuclear weapons, including enshrining their possession in its Constitution and emphasizing the simultaneous development of nuclear weapons and the North's economy.

Important developments point to the further elaboration of the requirements for deterrence to buttress assured retaliation and perhaps some initial thinking on the use of nuclear weapons in a wider range of contingencies:

- The reorganization of the Ballistic Missile Training Guidance Bureau into the Strategic Forces Command that appears to have the same status as the ground forces, Navy and Air and Anti-Air Commands elevated the significance of the North's deterrent in its defense strategy.
- The continued acquisition of weapons necessary to further develop a survival nuclear force better able to fulfill the deterrence mission including longer-range mobile weapons—the Musudan IRBM and KN-08 ICBM—and possibly sea-based cruise and ballistic missiles.
- Pyongyang has made significant progress in the production of fissile material and is striving to develop more advanced, miniaturized weapons that can be mounted on its delivery systems. (The North has also made numerous public references to the importance of developing miniaturized nuclear warheads for ballistic missiles.)
- North Korea has conducted an increasing number of ballistic missile exercises during the last five years that have increased in size, realism (e.g., shoot-and-scoot), complexity (e.g., volley and time-on-target fire missions) and demonstrated capabilities (e.g., atypical flight trajectories). These capabilities are applicable to the use of both conventional and nuclear weapons in wartime.
- The past five years have also witnessed a new sophistication in the North's articulation of its nuclear weapons strategy—the practical military application of these weapons and their utility in pursuing political priorities—that may be intended for external as well as internal audiences.[10] Much of the rhetoric is very similar to US and Russian terminology, with nuclear weapons usage characterized in battlefield, operational and strategic terms. However, while these statements on the surface suggest an important evolutionary step in the North's thinking about deterrence and strategy, they may also be understood as political rhetoric employed to mimic US statements or as an aspirational objective of KPA planners given the current small size of the North's nuclear stockpile and limited delivery capabilities.

[10] This language and terminology is reflected in the SPA Law as well.

Nuclear Strategy in 2020

All of these developments would seem to indicate that Pyongyang is striving for a policy of deterrence based at the very least on a more credible assured retaliation capability. This approach is reflected in North Korea's policy adopted by the SPA in 2013: "(Nuclear weapons) serve the purpose of deterring and repelling the aggression and attack of the enemy against the DPRK and dealing deadly retaliatory blows at the strongholds of aggression…"

The key question for the future is whether Pyongyang has the ambition to establish deterrence based on a strategy beyond assured retaliation that includes options for the limited initial use of nuclear weapons in order to bolster the credibility of deterrence. The SPA "Law on Consolidating Position of Nuclear Weapons State" appears to at least posit the expansion of the role of nuclear weapons beyond deterring high-end attacks to also deter and repel lower levels of aggression using its nuclear weapons as a future objective. It states: "The DPRK shall take practical steps to bolster up the nuclear deterrence and nuclear retaliatory strike power both in quality and quantity to cope with the gravity of the escalating danger of hostile forces' aggression and attack."

Logically, it may make sense for Pyongyang to move beyond relying on assured retaliation to a posture that threatens the limited early use of nuclear weapons to deter attacks by superior conventional forces. Just like NATO was confronted by the Soviet Union during the Cold War and Pakistan faces a superior India today, Pyongyang is confronted by more capable American and South Korean conventional forces. However, if the North evolves in this direction, it will have to address some difficult issues, particularly the reality that such a strategy will require a much more sophisticated command and control system with some pre-delegated authority to commanders to use those weapons as well as integration of nuclear weapons into its broader military doctrine.

There are some hints that the North may move to address the second problem. The Central Committee of the Workers' Party released a report one day before the SPA Law was issued directing the military to begin such planning: "The People's Army shall perfect the war method and operation in the direction of raising the pivotal role of the nuclear armed forces in all aspects concerning war deterrence and war strategy, and the nuclear armed forces should always round off the combat posture." But on the issue of command and control, launch authority remains highly centralized and the prerogative of the "Supreme Commander of the Korean People's Army" as might be expected in a regime like North Korea. While change in this practice appears unlikely, it is also difficult to predict, in part because Kim Jong Un's leadership style is still evolving.

Aside from technological challenges, an additional factor to consider in predicting the future of Pyongyang's nuclear strategy is unique national circumstances. North Koreans often argue that military hardware has to be adapted to Korean circumstances and realities, an argument that probably also applies to nuclear weapons and seems particularly relevant given Kim Il Sung's past skepticism about the use of these weapons. To the extent Pyongyang's war plans are based on the expectation of actually winning and inheriting South Korea's wealth, avoiding widespread or indiscriminate and unnecessary damage would seem to be very important, once again driving the North in this direction. However, even in the context of building a force of more accurate,

lower yield nuclear weapons, there also may be a significant political/psychological barrier to their use by North Korean leaders on the peninsula, namely they would be used against their own people.

In this context, Pyongyang would probably have no such hesitation in using nuclear weapons against Japan. It would not be hard to imagine that if the tide turned against the North, in part because of Japan's role in assisting the US and South Korea, Pyongyang would not hesitate in using these weapons against civilian and military targets in that country.

Given the development of North Korea's deterrence strategy over time, its most recent manifestations and the possible technical, political and other challenges facing Pyongyang in formulating a future approach, how might North Korea's nuclear strategy evolve under the three scenarios postulated out in this paper?

- ***Low-end Scenario:*** A North Korea armed with 20 nuclear weapons and only minor improvements in its current force of delivery systems seems likely to continue to rely on a policy of assured retaliation, threatening the use of these weapons in response to a nuclear attack by the United States. That threat may be somewhat strengthened by limited deployments of more survivable sea-launched systems and the emergency operational status of the Taepodong ICBM. In that context, if necessary, the use of these weapons against targets in South Korea will be allowed only under extreme conditions. The threshold for use against targets in Japan will be lower.
- ***Medium Scenario:*** With a nuclear deterrent of 50 nuclear weapons, a growing range of yields, additional mobile theater-range delivery systems possibly including greater numbers based at sea, and an emerging intercontinental force, Pyongyang will possess a more survivable and robust assured retaliatory capability able to more credibly threaten the United States. Pyongyang's greater assured retaliatory capability may allow the development of some limited options for the use of these weapons in a conflict against theater targets, particularly in Japan. Still, the limitations on nuclear use on the Korean peninsula will remain significant.
- ***High-end Scenario:*** A North Korea armed with 100 low, medium and high-yield nuclear weapons that can be mounted on an array of battlefield, theater and intercontinental delivery systems would certainly have an even more robust assured retaliatory capability. In addition, because of the size of the force as well as its variety of delivery systems and nuclear devices, the North could consider a further evolution in its nuclear strategy beyond assured retaliation to allow for threatening "first use," but only under certain conditions. In that context, battlefield nuclear weapons would be integrated into Pyongyang's war plans and the limited use of these weapons on the peninsula would be provided for under certain conditions. The threshold for use against Japan would be lowered as well.[11]

[11] Nuclear strategies do not necessarily dictate how these weapons might actually be used during crisis or conflict. "No first use" can quickly become first use and a "first use" strategy could be overridden in favor of restraint.

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