A US-KOREA INSTITUTE AT SAIS REPORT

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## *A Strategy for the Future*

Joel S. Wit, Andrew Hood, Jeffrey Lewis, Scott Pace and Leon Sigal

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# ABOUT THE AUTHORS

**Joel S. Wit** is concurrently a visiting scholar at the US-Korea Institute at Johns Hopkins School of Advanced International Studies (SAIS) and a senior research fellow at Columbia University Weatherhead Institute for East Asian Studies. He worked for 15 years in the US Department of State on arms control and nonproliferation issues. From 1995-2002 he was the implementation coordinator for the US-North Korea Agreed Framework. After leaving the government, he was a senior fellow at the Center for Strategic and International Studies and a member of the cooperative threat reduction project led by Robert Einhorn and Michelle Flournoy. He is currently a member of the Seoul Nuclear Security Summit Study Group (SNS3G) and the founder of "38 North" (www.38north.org). Moreover, he has been a frequent participant in Track II meetings with DPRK Foreign Ministry and other officials. Mr. Wit is the co-author of *Going Critical: The First North Korean Nuclear Crisis* (Brookings Institute Press, 2004), and has written numerous journal and newspaper articles on North Korea.

**Andrew A. Hood** has been the executive director of the Science and Technology Center in Ukraine (STCU) since August 2004. STCU is a multilateral organization with diplomatic status, established in 1994 and dedicated to preventing the spread of WMD technical know-how by engaging and redirecting ex-USSR weapons scientists and technicians to peaceful, sustainable civilian research employment. STCU is governed by an intergovernmental Governing Board and operates five former Soviet countries. Prior to this position, he was the senior coordinator of the Science Centers at the US Department of State in Washington, DC where he was in charge of coordinating all US participation in the STCU and in the STCU's sister center, the International Science and Technology Center (ISTC) in Moscow. Mr. Hood also served as director of the US Science Centers Program, the primary US government program on nonproliferation of WMD science and technology expertise. He was involved in the development of US nonproliferation policies to secure WMD expertise worldwide, including the preliminary program planning for US engagement of former weapons scientists in Iraq and Libya. Mr. Hood holds an M.A. in Diplomacy/Military Science from Norwich University and a B.S. in Aerospace and Ocean Engineering from the Virginia Polytechnic Institute and State University. He also is a graduate of the US Naval War College's Command and Staff College.

**Jeffrey Lewis** is director of the Nuclear Strategy and Nonproliferation Initiative at the New America Foundation. Dr. Lewis is the author of *Minimum Means of Reprisal: China's Search for Security in the Nuclear Age* (MIT Press, 2007). He is a research scholar at the Center for International and Security Studies at the University of Maryland School of Public Policy (CSSIM) and a contributor to the *Bulletin of the Atomic Scientists*. He also founded and maintains the leading blog on nuclear arms control and nonproliferation, www.ArmsControlWonk.com. Before joining the New America Foundation, Dr. Lewis was executive director of the Managing the Atom Project at the Belfer Center for Science and International Affairs. Previously, he served as a research fellow at the Center for International and Security Studies at the University of Maryland School of Public Policy (CISSM), executive director of the Association of Professional Schools of International Affairs, and visiting fellow at the Center for Strategic and International Studies and with the Office of the Undersecretary of Defense for Policy. He received his Ph.D. in Policy Studies (International Security and Economic Policy) from the University of Maryland and his B.A. in Philosophy and Political Science from Augustana College.

**Scott Pace** is the director of the Space Policy Institute and a professor of practice in International Affairs at George Washington University's Elliott School of International Affairs. From 2005-08, he served as the associate administrator for Program Analysis and Evaluation at NASA. Prior to NASA, Dr. Pace was the assistant director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). He served on the Bush-Cheney Transition Team for NASA and the National Science Foundation. From 1993-2000, he worked for the RAND Corporation's Science and Technology Policy Institute (STPI), a federally funded research and development center for the Office of Science and Technology Policy. Dr. Pace was a key member of a successful international effort to preserve radio navigation satellite spectrum at the 1997 World Radiocommunication Conference (WRC-97) and the addition of new spectrum for satellite navigation at WRC-2000. He also was a member of the Department of Defense's Senior Review Group on Commercial Remote Sensing and the National Research Council's Committee on Earth Sciences. Dr. Pace received a B.S. in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989. His dissertation was entitled "US Access to Space: Launch Vehicle Choices for 1990-2010."

**Leon V. Sigal** is director of the Northeast Asia Cooperative Security Project at the Social Science Research Council in New York. His book, *Disarming Strangers: Nuclear Diplomacy with North Korea* (Princeton University Press, 1999), was one of five nominees for the Lionel Gelber Prize as the most outstanding book in international relations for 1997-98 and was named the 1998 book of distinction by the American Academy of Diplomacy. His most recent book was *Negotiating Minefields: The Landmines Ban in American Politics* (Routledge, 2006). Sigal was a member of the editorial board of *The New York Times* from 1989-95. He served in the Bureau of Politico-Military Affairs at the US Department of State, in 1979 as International Affairs Fellow and in 1980 as Special Assistant to the Director. He was a Rockefeller Younger Scholar in Foreign Policy Studies at the Brookings Institution from 1972-74 and a guest scholar there from 1981-84. From 1974-89 he was a professor of government at Wesleyan University. He was an adjunct professor at Columbia University's School of International and Public Affairs from 1985-89 and again from 1996-2000, and a visiting lecturer at Princeton University's Woodrow Wilson School in 1988 and 2000.

# INTRODUCTION

While public attention has been focused on restarting denuclearization talks with North Korea, an important component of any renewed dialogue with Pyongyang will be controlling its ballistic missile program. That effort has been moving gradually but steadily ahead since the North ended its unilateral test moratorium in 2006 with the further development of threatening technologies, as well as the deployment of new models. Secretary of Defense Robert Gates recently highlighted the dangers posed by this effort during his January trip to Asia. He stated, "With the North Koreans' continuing development of nuclear weapons and their development of intercontinental ballistic missiles, North Korea is becoming a direct threat to the United States, and we have to take that into account."[1] The combination of North Korea's growing nuclear weapons stockpile and increasingly capable delivery systems will pose a serious danger to the region, and eventually perhaps even to the United States. In short, if the Six Party Talks resume, a high priority for the United States will be to also start negotiations that cover missiles.

However, little if any thought has been given both among the governments involved and the expert community, to a strategy for missile talks with North Korea. Devising such a strategy would not require Washington to start from scratch since it held missile negotiations with Pyongyang in the late 1990s that almost led to a breakthrough agreement. While that negotiation could serve as a baseline for future talks, a new strategy would need to take into consideration the fact that over a decade has passed since those discussions ended and the overall political, military and security context has changed. This paper attempts to flesh out a strategy for future missile negotiations that builds on past experiences and addresses the current situation on the peninsula.

1 John Pomfret, "Defense secretary Gates says North Korean ballistic missiles pose 'direct threat' to U.S." *Washington Post*, January 11, 2011. http://www.washingtonpost.com/wp-dyn/content/article/2011/01/11/AR2011011103260.html (accessed October 10, 2011).

# NORTH KOREA'S BALLISTIC MISSILE THREAT

North Korea maintains an active effort to develop ballistic missiles ranging from short-range, essentially battlefield weapons, to longer-range missiles able to reach targets in the region and beyond.[2] Most of these missiles are based on old Soviet Scud technology initially acquired from Egypt; variants of the Scud and the longer-range Nodong are able to reach targets in Japan. In 2008, General Burwell Bell, then Commander of United States Forces Korea (USFK), stated that North Korea had approximately 800 MTCR-class ballistic missiles, including approximately 600 Scud variants and another 200 Nodong missiles.[3] Recent South Korean reports have suggested the North Korean MTCR-class inventory may now number as many as 1,000 ballistic missiles. In addition, North Korea has a large stockpile of shorter-range missiles and rocket artillery.

In practice, several missiles are assigned to each launcher. A common ratio is six or eight missiles per each launcher. A typical strategic missile battalion contains a small number of launchers, with many more missiles available for reloading. A Scud-class missile can take between 60 and 90 minutes to prepare to re-fire.[4] As a result, the North Korean ballistic missile force is believed to comprise fewer than 100 short-range ballistic missile launchers, fewer than 50 Nodong launchers, and fewer than 50 Musudan launchers (see Table 1).

North Korea is also developing longer-range ballistic missiles able to reach the United States. Pyongyang tested a Taepodong-1 in 1998, and Taepodong-2s in 2006 and 2008. The first test failed, but the two subsequent tests succeeded in getting the missile's second stage to ignite before failing. In 2009, the North test-launched the Unha-2, which represented a significant stride forward in developing a long-range weapon. The missile incorporated more advanced technology than that of the Taepodong-1 and was able to carry a larger payload over longer distances. For example, a three-stage missile based on the Unha-2 could carry a 1,000 kg nuclear warhead to ranges in the vicinity of 10,000-10,500 km, sufficient to reach Alaska, Hawaii, and roughly half of the lower 48 states. A two-stage missile based on the same design could carry larger warheads 6,000 km, enabling it to reach targets in Alaska and Guam.

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2 Policy discussions about constraining emerging ballistic missile programs emphasize so-called "MTCR-class missiles"—those missiles governed by the Missile Technology Control Regime, which regulates the export of ballistic missiles capable of carrying a 500 kg (1100 lbs) payload to more than 300 km (185 miles). The range/payload definition of the missiles subject to control is somewhat arbitrary—in the aftermath of the Gulf War, for example, UNSC 687 prohibited Iraq from possessing missiles capable of a range greater than 150 km regardless of payload. Nevertheless, the 300 km range remains an approximate, if imperfect, definition of a nuclear-capable ballistic missile.

3 See the testimony of General Burwell Bell in 2006, 2007 and 2008, as well as answers to advance policy questions submitted by Sharpe (2008).

4 *North Korea Country Handbook*, Marine Corps Intelligence Activity, MCIA-2630-NK-016-97, May 1997, A-48.

Table 1: North Korean MTCR-class Ballistic Missiles in 2000 and 2009

| Missile | Stages | Fuel | Deployment | Range | Number (launchers) | |
|---|---|---|---|---|---|---|
| | | | | (mi) | 2000 | 2009 |
| Scud B | | Liquid | Road-mobile | 185 | Fewer than 50 | Fewer than 100 |
| Scud C | | Liquid | Road-mobile | 310 | Fewer than 50 | |
| Toksa | | Solid | Road-mobile | 75 | Fewer than 50 | |
| Extended-range Scud | | Liquid | Road-mobile | 435-625 | | |
| No Dong | 1 | Liquid | Road-mobile | 800 | Fewer than 50 | Fewer than 50 |
| IRBM | 1 | Liquid | Mobile | 2000+ | | Fewer than 50 |
| Taepodong-1 | 2 | Liquid | Undetermined | 1250+ | Not yet deployed | |
| Taepodong-2 | 2 | Liquid | Undetermined | 3400+ | Not yet deployed | Not yet deployed |

Source: National Air and Space Intelligence Center, *Ballistic and Cruise Missile Threat*, 2000 and 2009 editions.

Note: A black square denotes that the missile was not mentioned in that issue of Ballistic and Cruise Missile Threat. So, for example, the 2000 report made no mention of the Toksa, extended-range Scud or Taepodong-2 missiles, while the 2009 report omits the Taepodong-1 missile.

While many of North Korea's ballistic missiles are based on Scud technology, there are some notable exceptions. In 2007, North Korea began deploying the Toksa, a short-range solid-fueled weapon based on Syrian "Scarab" ballistic missiles designed by the Soviet Union. This missile falls below both the MTCR threshold of 300 km, as well as the more demanding 150 km limit placed on Iraq. The Musudan missile, a liquid-fueled intermediate-range weapon is based on the Soviet SS-N-6 submarine launched ballistic missile. Finally, the Unha-2 is also believed to have a modified SS-N-6 as its second stage. Whether this reliance on Russian missiles indicates that Pyongyang's design and production capabilities are much less extensive than previously believed, that it has a facility to produce these weapons, or that Pyongyang has a stockpile of already completed Russian missiles remains unclear.

North Korea has been an active exporter of ballistic missiles and missile technologies to a variety of countries including Pakistan and Iran. Pakistan's Ghauri and Iran's Shahab are indigenous variants of the Nodong. In recent years its exports appear to have declined, perhaps as Pyongyang saturated the market for its ballistic missiles. Nevertheless, North Korean entities remain involved in proliferation of missile technologies despite recent United Nations sanctions enacted in the aftermath of the North's 2009 nuclear and missile tests, particularly in close cooperation with Iran, as highlighted in a recent UN report. The close cooperation between the two countries was demonstrated during the October 2010 North Korean military parade that showcased a new Nodong warhead that was very similar to the triconic warhead carried by the Iranian Shahab-3 missile.

Relatively little is known about the North Korean infrastructure for producing ballistic missiles. Defectors describe a number of different facilities, all located around Pyongyang, said to be responsible for production of Nodong missiles and derivatives like the Taepodong. It is uncertain if defectors are using different names for the same facility, describing multiple redundant production facilities, or describing separate entities involved in the production of components. Given the relatively low rates of production—half a dozen a month—it is possible that North Korea has just a single final assembly facility, as well as other facilities to make rocket motors, propellant and other components.[5]

A useful comparison can be found in Iraq, which had separate programs to produce liquid and solid-fueled ballistic missiles. UNSCOM/UNMOVIC inspectors visited dozens of facilities in Iraq that were linked to the country's ballistic missile programs. Iraq had roughly a dozen primary facilities. Iraq's solid-fueled ballistic missile program, for example, had three main plants, to produce engine components, produce propellant and perform final assembly. North Korea could easily have three or four facilities of interest for each cluster of missiles: Scud and Scud-derivatives like the Nodong and Taepodong, the solid-fueled Toksa and the liquid-fueled Musudan.

North Korea may have a similar infrastructure in which multiple factories manufacture propellant, engine components and guidance systems that are assembled at another facility. North Korea might have as many as three distinct infrastructure clusters: one for Scud-based ballistic missiles, another for solid-propellant ballistic missiles and a third for Musudan missiles. The size of the infrastructure would depend on whether North Korea produces the components or performs kit assembly on some missiles, such as the Musudan, with components imported from abroad.[6]

Finally, North Korea also has two flight-test facilities. Pyongyang has launched its multi-stage rockets from a site in *Musudan-ri* on the east coast of the country near the East Sea, a fairly rudimentary facility that, according to one expert, "was nothing more than a place they go when the weather was right to launch their missiles."[7] The most recent test from that site was in April 2009 when the Unha-2 launcher failed to place a small satellite into orbit.

A new site nearing completion, located near Tongchang-dong on the Western Coast, is a bona fide launch control center that has been under development for over a decade. Much bigger and more sophisticated than Musudan-ri, it includes improved roads, a rocket engine test stand, missile assembly and test buildings, a launch bunker, an observation tower and a recently completed launch tower that is significantly taller than the old site—50 versus 32 meters.[8] Its location allows Pyongyang to avoid overflying any country during boost phase by launching south. The new tower, while capable of testing longer-range ballistic missiles, seems designed to fire even larger space-launch vehicles along the lines of current Chinese rockets. In short, the site is not designed solely for the development of missiles but can be used for both missile development and space launches.[9]

5 The best summary of North Korea's ballistic missile production infrastructure is Daniel A. Pinkston, *The North Korean Ballistic Missile Program*, Strategic Studies Institute, (February 2008), 44-45.
6 For an argument suggesting that North Korea's production infrastructure resembles kit assembly, see: Robert Schmucker, *3rd World Missile Development—A New Assessment Based on UNSCOM Field Experience and Data Evaluation*, (June 1999), 8-11; and Robert Schmucker and Markus Schiller, *The DPRK Missile Show: A Comedy in (Currently) Eight Acts*, May 5, 2010.
7 Steve Herman, "New North Korean Space Launch Site Appears Completed," GlobalSecurity.org, February 16, 2011. Accessed at http://globalsecurity.org/space/library/news/2011/space-110216-voa01.htm.
8 Ibid.
9 David Wright, "Secretary Gates and the North Korean Missile Threat," *38 North*, January 27, 2011. http://38north.org/2011/01/secretary-gates-and-the-north-korean-missile-threat.

# MISSILE NEGOTIATIONS: AN APPROACH

In shaping a future missile negotiation strategy, the United States and other potential participants should take into consideration a number of factors. First, while it has been over a decade since Washington and Pyongyang conducted serious missile talks and circumstances have changed, that experience can illuminate key issues facing future negotiators and provide hints as to what strategy might have the best chance for success.

In the waning days of the Clinton administration, the United States and North Korea made significant progress in reaching an accord that would have halted Pyongyang's development, production and export of ballistic missiles in exchange for compensation from the United States. Washington sought such an agreement as an outcome of the so-called Perry Process, chaired by former Secretary of Defense William Perry, who proposed a systematic testing of North Korea's willingness to engage in improving relations. Moreover, North Korea's test of a long-range missile in the summer of 1998 demonstrated that Pyongyang was intent on developing new, threatening delivery systems. Ultimately, the administration ran out of time with President Clinton opting not to travel to Pyongyang to finalize the agreement. The Bush administration chose not to pursue such an arrangement, leaving a tantalizing question about the "near miss" in 2002. Although some technical details remained to be worked out, Clinton Administration officials believe they were very close to a final accord.[10]

The essential elements of the deal were that North Korea would agree to halt the development, production, deployment and testing of medium and long-range ballistic missiles and the export of those missiles and related technologies. In exchange for stopping missile development, the international community would provide satellite launch services, perhaps for three North Korean satellites per year. In exchange for halting the sale of ballistic missiles and related technologies, the United States would provide "in kind" compensation, perhaps several hundred million dollars worth of food or energy aid. The prospective US-DPRK deal went beyond a 1993 deal negotiated but never consummated between Israel and North Korea to ban missile exports to the Middle East in return for technical assistance in mining and agriculture.

While the United States prepared a draft framework agreement, as well as a confidential letter outlining the obligations of each side, significant details remained to be worked out:

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10 Accounts of the "near miss" in 2000 include, Michael Gordon, "How Politics Sank Accord on Missiles With North Korea," *New York Times*, March 6, 2001; Gary Samore, "U.S.-DPRK Missile Negotiations," *The Nonproliferation Review*, (Summer 2002), 16-20; and Madeleine Albright, "*Waging War, Pursuing Peace*," in *Madam Secretary: A Memoir*, (Miramax Books, 2005), 578-600.

- **Scope:** North Korea was willing to accept an agreement prohibiting missiles with a 500 km range or greater, capturing those weapons of greatest concern to the United States: the Nodong and Taepodong missiles. The United States sought an agreement that would have prohibited all North Korean missiles covered by the MTCR: those that could carry a 500 kg payload to 300 km or more. At issue was whether North Korea would eliminate its arsenal of Scud-B and Scud-C missiles. Washington believed that US allies like Japan and South Korea might have objected to any agreement that protected Washington's interests, but left them exposed to North Korean missiles. But since Pyongyang regarded those missiles as part of its conventional deterrent, it might have insisted on conventional force reductions by Seoul or, alternatively, reciprocal limits on South Korea. A related issue concerned verification. For example, the Nodong is derived from Scud mobile missiles, making verification of a partial cut-off difficult.

- **Existing Missiles:** The debate over range linked to a second issue: what to do with the missiles North Korea had already deployed. North Korean officials made it very clear that they were not willing to eliminate missiles already deployed without more extensive improvements in Pyongyang's security situation. US officials on the other hand, sought elimination of all DPRK ballistic missiles, including those deployed with conventional military units.

- **Verification:** The United States sought a verification regime in which North Korea would make an initial declaration and then allow access for US technical experts. North Korean officials were opposed to intrusive verification measures like on-site inspections, believing that Washington could rather rely on reconnaissance satellites and other national technical means. Privately, North Korean officials indicated that they might accept visits to production facilities in the context of conversion to civilian use.

Whether negotiations can be resumed where they left off is unclear although given developments over the past decade it would seem highly unlikely. Much has changed since those discussions. First, North Korea has made important progress in developing long-range missiles and has deployed significantly more weapons, including a new type of liquid-fueled intermediate-range ballistic missile. Moreover, it has deployed the Toksa, a 120 km-range solid-fueled replacement for North Korea's FROG (Fire Rocket over Ground) missiles. Although that system would fall below the threshold of a likely agreement, the fact that Bush administration officials highlighted its deployment may make it more difficult for any future US administration to ignore it completely in future negotiations.[11] In recognition of these advances in Pyongyang's missile forces, a senior North Korean official suggested in a recent private meeting that it would be difficult to just pick up where the Clinton administration negotiations left off.

Second, North Korea has forcefully declared that it possesses a nuclear deterrent that potentially depends on missiles for delivery. Pyongyang was reluctant to discuss elimination of already deployed missiles in 2000. The announcement that it possesses nuclear weapons most likely reinforces this reluctance, and more tightly binds the disposition of already deployed missiles to broader improvements in the US-DPRK relationship, including progress on denuclearization.

Third, South Korea's missile program has made advances over the past decade, as has Japan's space program, raising the possibility that North Korea would want any limitations it accepts to apply

11 Robert Burns, "U.S. Official: North Korea Has New Missile," Associated Press, July 6, 2007.

reciprocally to them. South Korea has long sought to develop a missile with a range in excess of the 300 km MTCR limit, although Washington has tried to dissuade it from doing so.

While future talks may not be able to pick up where past discussions left off, they can provide at least a baseline for a strategy that consists of three tracks, each successfully pursued with other countries either in efforts to eliminate missile threats or in the course of peaceful international cooperation. They are:

- **Arms Limitation:** Two treaties between the United States and Soviet Union contained provisions relevant to a possible agreement with North Korea. The 1987 Treaty on Intermediate Range Nuclear Forces (INF Treaty) eliminated all US and Soviet ballistic missiles with ranges between 500 and 5,500 km. The 1991 Strategic Arms Reduction Treaty (START) imposed numerical limits on "strategic" ballistic missiles. These treaties also included a variety of provisions to verify these limits, including on-site inspections, continuous portal and perimeter monitoring of missile production facilities and a prohibition on interference with national technical means. Restrictions on where treaty-limited ballistic missiles could be deployed, as well as a prohibition on the encryption of flight test data were part of START.

  Other historical experiences may provide some useful guideposts for future US-DPRK talks. After the defeat of Iraq in the first Gulf War, UNSC 687 imposed ceasefire terms on Iraq that prohibited Baghdad from possessing or developing ballistic missiles with ranges greater than 150 km regardless of payload size. The UN Security Council also created inspection entities to ensure that Iraq was complying with these commitments: first, the United Nations Special Commission (UNSCOM) and then the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) in 1999. Prior to the 1991 Gulf War, Iraq pursued the development of a number of ballistic missiles. Afterward, Iraq continued to develop ballistic missiles within the 150 km constraint imposed by the UNSC, although inspectors concluded that some of these programs exceeded that range limit.

  UNSCOM/UNMOVIC was charged with verifying that Iraq had eliminated its proscribed weapons programs, as well as monitoring its compliance. Inspectors faced a particular challenge in enforcing the more stringent 150 km-range standard. In practice, UNMOVIC found it necessary to define additional technical constraints, such as diameter restrictions on Iraq's ballistic missiles, to prevent Iraq from developing missiles that exceeded the 150 km-range limit.[12] Monitoring Iraq's ballistic missile programs also required them to have significant access to technical information about its ballistic missile programs and included measures such as regular declarations, on-site inspections, static and test flight observations, use of remote cameras, inventorying of equipment and tools, documents and computer searches and tagging of missile hardware.

  Unlike Iraq, Libya in 2003 voluntarily agreed to eliminate its "weapons of mass destruction" programs, including all MTCR-class ballistic missiles.[13] This elimination was pursued in stages. Initially, Libya provided a declaration regarding missile research and development activities and

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12 UNSCOM restricted Iraqi missile programs in 1994 to having a diameter of no more than 600 mm after reviewing plans to modify the Al Samoud missile.
13 Libya's ballistic missile program included approximately 100 Scud-B and five North Korean-supplied Scud-C ballistic missiles, as well as programs to produce these missiles.

permitted the United States to remove parts from Libya's small number of Scud Cs to render them inoperable. Later the United States removed the entire inventory of Scud-C missiles, believed to be about five missiles. Libya also agreed to convert its inventory of approximately one hundred Scud-B ballistic missiles to shorter-range missiles.[14] Technical details of the proposed conversion program are not available in the open source literature and the ultimate disposition of these missiles remains unclear. One report suggested that Libya later sought to sell the United States the inventory of Scud-B ballistic missiles.[15]

- **Cooperative Threat Reduction:** Such a program is implicit in North Korea's requests for assistance in converting factories for civilian uses and for finding new work for former missile program employees. Moreover, past experience has shown that cooperative threat reduction (CTR) can play a key role in ballistic missile reductions or elimination, particularly increasing transparency and in aiding verification of arms limitation measures.

  After the collapse of the Soviet Union, Ukraine inherited not only a large number of nuclear warheads, but also a significant number of ballistic missiles (SS-19 liquid-propellant ICBMs and SS-24 solid-propellant ICBMs), as well as ballistic missile and space launch vehicle design bureaus, R&D and engineering institutes and production complexes. Ukraine faced many challenges surrounding the elimination of these missiles and in coping with the excess or under-utilized production and support complex.

  While there were many contributing factors to that country's political decision to give up its inherited strategic offensive arms, CTR assistance was a key factor. In particular, the United States offered technical and infrastructure assistance that encouraged the Ukrainian government to pursue missile elimination and helped to mitigate the negative impacts of "right sizing" an under-employed missile complex. These CTR projects included: 1) construction of special facilities for the safe elimination of missiles; 2) programs to facilitate the conversion of former missile production facilities to non-missile activities, including projects to establish civilian commercial business lines in windmill power generation, vibration damping/absorption systems, agricultural storage systems and in MTCR-controlled commercial space launch vehicle services; and 3) specially tailored programs to assist former missile R&D scientists and technical experts in their transition to peaceful, civilian work, including the cooperative multilateral Science and Technology Center in Ukraine (STCU), as well as the bilateral US Civilian Research and Development Foundation (CRDF) and European Technical Assistance for the CIS (Tacis) programs.

  These cooperative activities served several supporting roles for Ukraine, its neighbors and partners. First, cooperative assistance encouraged Ukraine to undertake elimination (rather than keep the missiles) since the costs and complexity of these elimination projects was one possible barrier.[16] Second, the close, on-site interaction in these projects created a level of transparency that achieved a certain confidence in Ukraine's commitment to follow through on its political agreements. Third, CTR activities helped to create underlying, positive relationships among the

14 Judith Miller, "U.S. Says Libya Will Convert Missiles to Defensive Weapons," *New York Times*, April 11, 2004.
15 Sharon Squassoni, *Disarming Libya: Weapons of Mass Destruction*, Congressional Research Service, RS21823, September 22, 2006, 4.
16 Ukraine did send some ballistic missiles to Russia in exchange for settling outstanding gas debts.

Ukrainian, American and other participants, which encouraged the parties to work diligently in overcoming obstacles and in considering future steps.

While past CTR activities in Ukraine, other ex-Soviet countries, Iraq and Libya can provide valuable experiences for the DPRK case, there may be notable differences that could make conducting such programs in North Korea more challenging. In previous threat reduction programs, the political atmosphere was conducive to cooperation and there existed common interests in seeing the objectives accomplished. One can assume that, at least initially, while the North Korean regime may sign off on agreements, the political atmosphere will be much less positive.

Because of simultaneous activities in arms reduction and space cooperation, there will likely be a coordination challenge created by all these moving parts. This will affect important implementation issues ranging from the sharing of information between involved parties to bringing the best expertise to bear on cooperative activities (whether that involves the United States which has the deepest programmatic and technical expertise, Russia and Ukraine which have their own on-the-ground experiences, other European states who have played important supporting roles or multilateral approaches, such as the International Science Centers in Moscow and Kyiv which have proven to be more effective in converting ex-missile personnel to civilian employment).

Another potential challenge will be the state of the DPRK ballistic missile complex and aerospace industry. At the time of its independence, Ukraine inherited a developed aerospace sector, where commercial aviation and space activities formed a major part of the economy. Ukraine also had a long academic and technical tradition within its universities and institutions, including a governmental space agency for setting aerospace policy and governmental support. Thus, it was relatively easy for CTR programs to work with Ukraine in integrating its military-oriented missile complex into the existing civilian aerospace sector (although parts of the Ukrainian missile complex continue working on state defense needs). North Korea's situation may be different since one can assume that the DPRK missile complex is probably designed solely for military needs and any existing civilian aerospace sector may not be capable of facilitating a military-to-civilian conversion process. Therefore, the North may have less room to negotiate away its military missile capability than was the case with Ukraine (or, as was the case in Libya, the DPRK might view their small missile complex as too dear to give up).

Beyond these problems, establishing regular access to the DPRK missile complex so as to ensure sufficient transparency will be another critical challenge. The ability to effectively monitor activities at acceptable intervals has been a stumbling block in former Soviet CTR activities. Even in the case of some Ukrainian projects, there have been misunderstandings about what areas and personnel foreigners could access. As time passed and trust grew these issues became less acute. Given the sensitivity of the DPRK to the presence of foreigners (particularly with regards to its military sites), sufficient access to cooperative projects in missile facilities will be even more challenging and should be a critical focus of all agreements. Acceptable levels of access should be a discussion topic in all of the early meetings and workshops with the DPRK related to designing these cooperative activities.

Another challenge will be formulating clear procedures for implementing cooperative missile reduction projects inside the DPRK. The precedents established by past experiences, such as the Korean Peninsula Energy Development Organization (KEDO) and other inter-Korean agreements, may be a starting point for establishing such procedures. But the challenge will be the tolerance of the DPRK leadership to externally imposed rules-of-the-game, and the degree to which the other cooperation partners are willing to be flexible in what they deem to be acceptable procedures. In several cases, CTR projects in Russia and Ukraine ran into operational problems due to miscommunications or misunderstandings about procedures. Moreover, past experiences have shown that major construction projects always pose significant procedural challenges in the former Soviet Union countries. Thus, one can expect to have long, detailed negotiations with the DPRK on establishing clear, understandable and mutually acceptable plans for implementing cooperative missile reduction projects. But one should still expect to encounter quite a few implementation problems (especially at the outset of a project) until the procedures are fully exercised.

Still, it is likely that another ongoing concern will be the risk of dual-use applications, namely the implementation of cooperative missile reduction activities inside the DPRK that inadvertently promote adverse behavior or contribute to a military capability. Many former Soviet CTR projects that were not related to arms destruction or facility elimination often ran into questions about whether the programs were keeping a latent weapons capability on life support, rather than putting it into the grave. Former missile facilities converted to civilian work could, theoretically, be changed back to military-related production. The design differences between a commercial space launch vehicle and a ballistic missile are minor. Scientists and engineers possess aerospace expertise that can be used in either weapons or non-weapons work. So there is a great reliance on the recipient country to live up to its political commitments to nonproliferation treaties and other agreements (e.g., the MTCR). Ukraine appears to have kept its political commitments and there is general confidence that it has not violated them. But can the same trust be placed in the DPRK?

Finally, a DPRK cooperative missile reduction program must have sufficient checks and balances, as well as enforcement mechanisms (e.g., financial controls) that can guide the process and reduce the dual-use risk of the activity. This is not easily done and in the end the parties will likely have to accept a certain amount of trust in the DPRK commitment to live by the access, transparency and oversight controls needed to ensure confidence in the cooperative missile reduction process.

- **Peaceful Space Cooperation:** While peaceful space cooperation was a key component of Clinton administration negotiations, the provision of alternative launch services to North Korea was the most obvious manifestation of its importance. Pyongyang's continued interest in developing a peaceful space program may open the door for other cooperative activities. These activities could benefit the DPRK's economic development and help solidify arrangements designed to end its missile programs.

  While North Korea has professed a strong interest in developing a peaceful space program, any objective evaluation reveals serious deficiencies in its efforts. North Korea's development of its own satellite can be traced back to the late President Kim Il Sung's decision to create such a program, announced at a 1993 meeting of the Korean Workers' Party Central Committee (and in the aftermath of South Korea's launch of its first satellite in 1992). His decision directed the creation of a satellite program that in turn, led to increased efforts to build the Paektusan-1 space launch vehicle.[17]

The August 31, 1998 launch of Paektusan-1 (aka Taepodong-1) attempted but failed to place the Kwangmyŏngsŏng satellite in orbit. While the DPRK claimed it had succeeded, the United States detected no sign of the satellite in orbit and no communications were ever heard from it. The first and second stages of the vehicle appear to have functioned but a third stage failure resulted in fragments traveling over 4,000 km due east down-range.[18]

After a period in which the DPRK suspended missile tests and a second firing of a long-range rocket in July 2006, the North made a second official space launch attempt on April 5, 2009 using an Unha-2 rocket, believed to be an improved version of the Taepodong-2, carrying a Kwangmyŏngsŏng-2 satellite. Supposedly more sophisticated than its predecessor, the North has characterized it as an experimental communications satellite that would broadcast on 470 MHz, consistent with bandwidth use of space-to-Earth telemetry. (In contrast the 1998 Kwangmyŏngsŏng-1, which bears a strong resemblance to Beijing's first satellite—the Dong Fang Hong 1—that was supposed to have operated on 27 MHz, commonly used for radio-control model planes and other toys.) While there is no evidence of Chinese involvement in developing the second satellite, strong doubts remain about the North's ability to field its own systems. As in 1998, the intended satellite did not achieve orbit: the first stage and initial stage separation functioned but the payload and third stage failed to separate from the second stage properly.[19] Moreover, the International Telecommunications Union dismissed the DPRK claim of a successful satellite launch saying that it had no information about a satellite or reports of communications with it.

In contrast to the 1998 launch attempt, the North took steps designed to demonstrate to the international community that its launches were part of legitimate, peaceful space activities. The DPRK sent formal notifications of the launch to the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO). In the month before the launch attempt, North Korea became party to the 1967 Outer Space Treaty and the 1974 Convention on Registration of Objects Launched into Outer Space, two fundamental international agreements of space law.

While the DPRK may have a nascent satellite program, its participation in external space organizations has been limited. The North belongs to few relevant organizations as either a Member State or with individual representatives (e.g., space scientists). Pyongyang has no representation at dedicated space organizations but does participate in other organizations that touch on space matters, such as weather and communications, including the Asia-Pacific Telecommunity that prepares regional positions on spectrum allocations for meetings of the ITU, and meetings of the World Meteorological Organization.

17 Hong-yul Paik, "Missile Issues of North Korea," unpublished briefing to the Space Policy Institute, May 24, 2010.
18 Ibid.
19 Ben Basely-Walker, "Some Technical and Legal Issues on the DPRK Launch," briefing to the Henry L. Stimson Center in Washington, D.C., on behalf of the Secure World Foundation, May 18, 2009.

Table 2: North Korean Involvement in Space-related Organizations

| | |
|---|---|
| UN Committee on the Peaceful Uses of Outer Space (COPUOS) | No membership. The Republic of Korea was first added to the committee on a rotating basis in 1994 and was granted permanent status in 2001. |
| UN Conference on Disarmament | No membership. |
| Outer Space Treaty & Registration Convention | Informed the Foreign Ministry of Russia that North Korea joined the 1966 OST on March 5, 2009. Also informed the Russian ministry that UN Secretary General Ban Ki-moon had been informed that North Korean joined the 1974 Convention on Registration of Objects Launched into outer space on the same date. |
| Committee on Space Research (COSPAR) | No delegation. |
| World Meteorological Association | Full member via State Hydrometeorological Administration. |
| International Telecommunications Union (ITU) | Full member via the Ministry of Posts and Telecommunications. |
| Asia-Pacific Telecommunity (APT) | Full member via the Ministry of Posts and Telecommunications. |
| Asia-Pacific Space Cooperation Organization (APSCO) | No membership. |
| Asia-Pacific Regional Space Agency Forum (APRSAF) | Non-participant. |
| International Astronautical Federation (IAF) | No memberships. |
| International Academy of Astronautics (IAA) | No memberships. |
| Space Generation Advisory Council | No representation. |

If North Korea were to become an active member of the international space community, it is unclear whether Pyongyang would have sufficient personnel for that purpose, particularly since drawing representatives from overtly military organizations would be unacceptable for both the North and the international community. It might choose an organization cited in past press releases, the Korean Committee of Space Technology (KCST), which appears to be the DPRK space agency responsible for satellites.[20] However, the KCST is probably connected to the Artillery Guidance Bureau of the Korean People's Army and reportedly operates the Musudan-ri (Tonghae Satellite Launching Ground) and Pongdong-ri (Tongch'ang-dong Space Launch Center) rocket launching sites, the Paektusan-1 and Unha-2 (aka Paektusan-2) launchers and the Kwangmyŏngsŏng satellites. Another alternative would be drawing from DPRK academic institutions such as Kim Il Sung University and Kim Chaek University of Technology, which train top-level students in science and engineering.[21] The State Academy of Sciences, responsible for national research and development efforts might also be a source of participants although the extent of cooperation with the military sector is unknown.[22]

In summary, North Korea, while perhaps interested in developing a space program, appears to lack the technical and organizational characteristics of a country with a serious commitment to space research, development and operations. In contrast, Iran, another country under international sanctions with a growing nuclear and missile program, has a more diverse and capable space effort for building and

20 "Preparations for Launch of Experimental Communications Satellite in Full Gear," KCNA (in English), February 24, 2009.
21 Pinkston, *North Korean Ballistic Missile Program*, 38-40.
22 Ibid.

operating satellites of some sophistication; it is also able to engage in international outreach, such as promoting projects to use space data for disaster relief, hosting a UN conference on space law, and maintaining a website in English for its space agency.[23] Iran is also an active member of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), ICAO, IMO, and a regular participant in regional and global meetings of the International Telecommunications Union (ITU). Iran's space capabilities were recently highlighted by its successful launch of what some experts believe is a military reconnaissance satellite that can also monitor crops and track damage from earthquakes, flooding and other natural disasters.[24]

Taking into account the limitations of North Korea's space effort, one important objective of future talks could be to assist Pyongyang in developing a more effective program. It is common to speak of nation states with space programs as belonging to the "space club" which is not a formal organization with written rules, but one based on the demonstrated technical capabilities of states.[25] Being part of this "club" is seen as having domestic and international prestige values by implying a certain level of technical sophistication. States vary greatly in their ability to exploit and use space, ranging from human space exploration at the highest levels to being able to use space-based information systems for practical applications such as communications, navigation, agriculture, construction and so forth.

Figure 1: Space Club Levels from Paikowsky (2009)

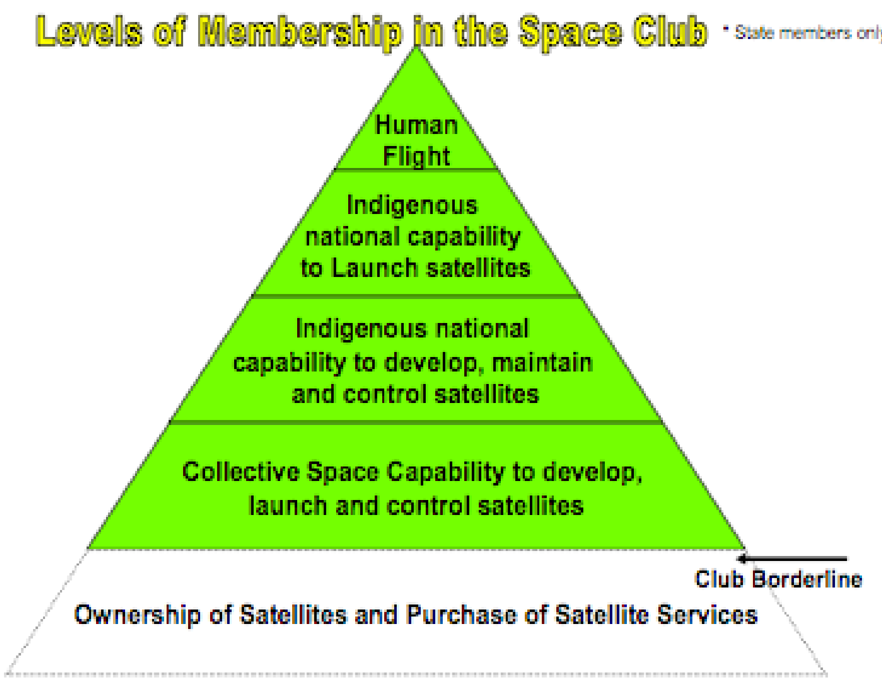


Figure 1 depicts one approach to thinking about the different levels of the space club. The base level is the collective ability (working with others) to develop, launch and control satellites—a capability that North Korea has not reached. Moreover, the DPRK does not appear to own any satellites and it is unclear

23 Iranian Space Agency website, in English. http://www.isa.ir/index.php.
24 Willam J. Broad, "After Delay, Iranians Launch a Satellite," *New York Times,* June 15, 2011.
25 Deganit Paikowsky, "The Space Club—Space Policies And Politics," IAC-09.E3.3.5, paper presented at the 60th meeting of the International Astronautical Congress, Daejeon, Korea, October 2009.

to what extent it purchases satellite communication services. The foundation of the entire pyramid is arguably the ability to exploit space technology for practical applications of all kinds. Even in this area, the North appears to be behind other developing countries due to restrictions on the kinds of information products that are a primary strength of space-based systems. As a comparison, Vietnam might be just barely in the space club while South Korea is working toward the indigenous capability to launch satellites. Other countries, lacking launch capabilities, are nonetheless seeking to develop indigenous satellite capabilities—a goal which is made easier with smaller "lightsat" technologies that are accessible to technically capable universities.

In this context, there are a variety of technical and organizational benchmarks for an indigenous national civil space effort, such as:

1. Accession to UN space treaties
2. Creation of national point of contact (e.g., space commission or agency)
3. Support for basic space-related scientific research
4. Ability to utilize space-based information in weather prediction
5. Ability to utilize remote sensing information in civil projects
6. Ability to construct and operate a small or micro-satellite to launch by others
7. Ownership and operation of large satellite for practical or scientific purposes, to include controlled end of life disposal
8. Contribution to an international scientific space mission (e.g., contribution of a experiment to a multinational project)
9. Participation in a major international space program (e.g., experimental payload flown on the International Space Station)
10. Development and operation of a large satellite with a domestic ground support tracking and communications network
11. Participation in a scientific mission at locations beyond the Earth's orbit
12. Participation in a human space flight mission

In looking to other countries in the Asia-Pacific region, the sophistication of North Korea's space efforts (aside from its long-range ballistic missiles) might be placed behind Bangladesh and Mongolia and comparable perhaps to Myanmar and Bhutan. Bangladesh and Mongolia both have dedicated centers of excellence for space applications like remote sensing and modest space science projects. Bangladesh has dedicated meteorological ground stations, image processing, geographic information systems and related mapping facilities. The National Remote Sensing Center of Mongolia supports local capabilities for monitoring natural resources, the environment and assessing natural disasters and pollution effects. They have agreements with the United States for data from polar-orbiting weather satellites and with Japan for research in environmental monitoring.

In contrast, Myanmar and Bhutan have only the most basic meteorological and mapping capabilities that could use space-based data. Since Bhutan is open to outside assistance in a way that Myanmar is not, Myanmar might be considered the closest civil space analog to the North. Of course, the North's missile developments represent a significant technical capability and cadre of skilled personnel.

However, building rocket engines is not the same as building advanced electronics and other information technologies necessary for civil space applications—as was demonstrated by the Soviet space program. In short, the North may have a nascent space launch vehicle, but it does not appear to have the capability to benefit from space applications as much as Bangladesh. Therefore, there would appear to be a great deal of room for cooperation should Pyongyang decide to build up its peaceful space efforts.

A sensible goal for such cooperation would be to achieve a peaceful space effort without space launch vehicles, comparable to Vietnam or Sri Lanka. Both have hosted international scientific meetings and are active participants in regional cooperation. Vietnam has a dedicated Space Technology Institute that pursues applications in areas such as communications, hydrometeorology, natural resources and environment and satellite-based positioning. Moreover, its Ministry of Posts and Telecommunications contracted with Lockheed Martin to build its first communication satellite, VINASAT-1, which was launched in April 2008 on a European Ariane rocket. Plans are underway for a follow-on VINASAT-2 satellite to provide television, voice and high-speed data services. Satellite coverage includes Vietnam, other Southeast Asian countries, Japan, the Korean peninsula and the South China Sea. In a similar vein, Sri Lanka is in the process of creating a space agency to improve its capabilities in satellite communications and remote sensing technology. Last year, the Sri Lankan Telecommunications Regulatory Commission contracted with UK-based Surrey Satellite Technology Ltd. (SSTL) to help it develop its own small communications and Earth observation satellite. This would be smaller and less expensive than the Vietnamese satellite but it would provide a modest independent capacity for contributing to United Nations disaster relief activities.

The North could accomplish the first six steps listed above with modest resources as part of general economic conversion and development. The first phase of cooperation would bring the DPRK to steps four or five. The second phase should bring it to steps seven and maybe eight. The seventh and eighth step would require more resources and represent the upper end of DPRK capacity without major foreign assistance. Moving to steps nine or above would require larger commitments of domestic resources which may be difficult without wholesale change in the political, economic, and diplomatic position of the DPRK. Thus steps nine and above may not occur until the third phase.

As mentioned before, DPRK acceptance of international norms and creation of domestic legal capacities will be an important early step for space cooperation. This situation is not unique to the DPRK but applies to all states seeking space capabilities. In the case of the United Arab Emirates (UAE), they developed a small (200 kg) remote sensing satellite (Dubaisat-1) with South Korea's help and launched it on a Russian booster in 2009. Less well-publicized is that the UAE has been developing a national space policy and updated domestic regulations to control satellite technologies and commercial remote sensing systems. These efforts build on past UAE experiences in owning and operating regional satellite communications (e.g., Thuraya) systems, a field in which they have been a leader for the Middle East. They have also been encouraged by the United States to develop their legal capacities so as to make it easier for private firms to invest in and cooperate with the UAE on commercial space projects. The UAE satellite projects are and have been more sophisticated than a possible DPRK micro-satellite would be, but the need for clear legal and managerial structures that operate in a predictable way for international partners will be the same.

It should be noted that there are no standard roadmaps for states to develop space capabilities. The United States, Soviet Union, China, Japan and Europe all took their own paths depending on internal and external political and economic drivers. The same diversity of paths continues to be exhibited among emerging space powers such as India, Brazil, South Korea and Israel. Thus any roadmap for creating a civil DPRK space program will have to take into account its unique political, economic and technical circumstances. Before discussing potential space cooperation ideas with the DPRK, the United States should have a clear idea of what options would be off limits. Barring political transformation, projects such as the placement of DPRK experiments on the International Space Station, flight of a DPRK astronaut by any party (even as a "tourist") and any transfers of controlled space or missile technology (i.e., MTCR or US Munitions List Category XV) would be off limits. Finally, in the first and even second phases, it would also seem prudent to rule out any exclusive bilateral cooperation with the United States outside of the Group of Six.

The level of economic and social development in the DPRK would make it unlikely for it to achieve space efforts comparable to Thailand, Indonesia and Malaysia, much less South Korea or Taiwan. These countries have multiple government agencies, private companies and universities capable of participating in international cooperation in almost every field of unmanned space activity, including communications, satellite-based navigation, remote sensing, environmental monitoring, weather, Earth science and space science. They are richer, more technically capable across multiple fields and more experienced at international cooperation than the DPRK is likely to be for decades. Indonesia, for example, was a pioneer in the use of US-built communications satellites (the Palapa series) to connect its many islands. It also has sounding rocket and short-range missile capabilities, launch ranges and ground-tracking stations, as well as weather and remote sensing data reception stations. Like South Korea, Malaysia has sent one of its nationals to the International Space Station using Russian launch services, part of an offset agreement involving the purchase of Sukhoi SU-30MKM fighter jets for the Royal Malaysian Air Force.

The exploitation of space technology is not solely determined by centralized engineering efforts in rocket engines and guidance systems. The advantages of exploiting space largely come from the information benefits achievable with space systems, the systems engineering skills necessary to operate successfully in space and the international relationships necessary to achieve scientific and economic benefits from space. It is possible for a state to create space launch vehicles without being able to create economically useful satellites, as was the case with the Soviet Union. A relatively poor country can pursue international cooperation that exploits space-based sensors, navigation and positioning data and communications for economic development without having satellites and launch vehicles of their own. States can use the prestige and public interest of space efforts to foster the development of higher-level technical skills and a more educated workforce as South Korea, China and Taiwan are doing.

# BUILDING A STRATEGY

The baseline provided by the 2000 negotiations and other past experiences suggest a future strategy that integrates these three tracks into a phased roadmap leading to the elimination of all DPRK missiles above the MTCR threshold. While the main driver for that effort will be the "arms limitation" track, the other two provide critical tools for negotiators designed to reinforce North Korea's willingness to agree to those measures. Moreover, in the case of verification, these other tracks, particularly cooperative threat reduction, can provide alternative paths to achieving the necessary transparency.

It is also worth noting that even a cursory examination of the detailed requirements for moving down this path points to the need for extensive cooperation and trust building. Whether that will be possible given the current situation between the DPRK and the international community remains unclear at best. A great deal will depend on the overall development of political and security relations, which, if positive, could help move down the missile elimination road. Nevertheless, it can be argued that even limited agreements in this area that cap the emerging DPRK threat through irreversible and verifiable measures would still serve the security interests of the United States, its allies, the region and the international community.

While this roadmap often alludes to the participation of other countries beyond the United States without a detailed examination, there would clearly be a role for others in the region, particularly China and Russia, as well as the international community. While the United States may decide to play a leading role in the arms limitation and elimination track, the experiences of third parties, such as Ukraine, in cooperative missile reduction projects could prove invaluable. The dense web of global space cooperation means that a variety of actors, from developing countries like Vietnam, to developed nations and multilateral organizations can be drawn upon to assist in any missile elimination effort.

An important related question will be the role of South Korea and Japan in any missile limitation process. Initially, the ability for both countries to be deeply involved in cooperative activities will be limited by political realities. However, that might change over time if increasingly restrictive limits on North Korea require including those countries' systems, either missiles or space launch capabilities. Moreover, given Japan's central interest in DPRK missile development, it will be important to carve out an important role for Tokyo in formulating an elimination strategy and in identifying possible contributions to threat reduction and space cooperation efforts. Once again, Japan's participation on those fronts may be limited initially by political realities, particularly if issues of concern related to past North Korean abductions of Japanese citizens remain unresolved.

Finally, it is worth highlighting the growing organizational complexity of implementing this three-track strategy. Pursuing such a strategy—particularly cooperative threat reduction and space assistance that require hands-on activities with the North Koreans—will require careful attention to establishing organizational structures to ensure effective implementation. Exactly what those structures should be is beyond the scope of this paper. But one suggestion would be the need for an overall coordinating body (perhaps composed of those countries who are the main parties to a missile elimination agreement) that might supervise other more technical groups charged with implementing each track of a final arrangement.

## Phase 1

*Arms Reduction*

The main US negotiating objectives for the first phase of missile talks should be to stop the further development by the DPRK of missiles that could potentially pose a threat to the United States, as well as to modernize regional delivery systems that could heighten the existing danger presented to key allies, Japan and South Korea. A related objective will be to end DPRK exports of missiles, components, technology and know-how, particularly to countries such as Iran that pose a danger to US interests in the Middle East and Europe. Such a measure might also have important political benefits, loosening the close ties between Pyongyang and Tehran, now focused on WMD development.

To achieve these objectives, Phase 1 should include:

- **A ban on test-launches of missiles with ranges greater than the MTCR guidelines**. Such a ban would be relatively easy to verify with national technical means able to gather information on missile tests and components such as rocket engines. There might be some ambiguity if the North tests missiles with ranges at or just above the 300 km threshold that could cause political problems, although such tests would unlikely be used in a covert effort to develop longer-range weapons. Whether cooperative measures would be politically feasible to help erase such ambiguities at this early stage of negotiations is unclear. For example, if North Korea encrypts ballistic missile telemetry, the parties may wish to consider a selective prohibition on such encryption for flight tests of ballistic missiles.

- **An Export Ban.** Demand for North Korean missiles may have slackened in the past five years, although there still seems to be considerable cooperation in technology and know-how between Pyongyang and Iran. Nevertheless, a ban might be attainable if the DPRK calculated it could get more for forgoing its exports than by continuing them. Verification would pose difficulties since the transfer of missiles, components and know-how is very difficult to monitor. UN Security Council Resolution 1874 authorizing port inspections of suspect cargoes has helped ease this problem, but that resolution may no longer apply if North Korea meets the requirements for having it rescinded. The Proliferation Security Initiative may also help but as long as air shipments remain impervious to intelligence and interception, exports may get through unnoticed. The lack of Chinese enforcement seems to represent an important gap in efforts to halt DPRK exports. But the conclusion of a formal export ban that might be endorsed by Beijing as a member of the Six Party Talks could help step up enforcement.

While both measures would represent significant steps forward given the long, tortured history of relations with the North, another key issue facing the US and its allies is whether any new negotiations should go further and duplicate the Clinton administration's attempt to capture systems such as the Nodong (and now the newer Musudan missile) at the very beginning of talks. In 2000, North Korea was unwilling to accede to US requests that deployed missiles with ranges of 300 km or above should be captured in any new agreement until the security situation improved. Since then, Pyongyang has fielded large numbers of additional weapons. Moreover, given both South Korean and Japanese missile development efforts since 2000, North Korea might demand that its efforts be included in a Phase 1 agreement, stalling talks. Finally, limits on deployed missiles will trigger the need for complicated, on-site verification measures that would be difficult if not impossible to negotiate at this early stage of the process.

Ultimately, any agreement might be similar in scope to the 2000 near miss with North Korea forgoing the deployment, production and export of MTCR-class missiles. But a principal compromise at this early stage of negotiations would seem to be North Korea's acceding to the US request to capture all missiles with a range greater than 300 km, in exchange for deferring negotiations on already deployed missiles to a later date when US-DPRK security relations improve. (Indeed, in 2000, the United States was poised to accept such a North Korean commitment.) Moreover, given the monitoring difficulties of such an agreement, an added feature of this compromise might also be to secure a North Korean commitment to accept measures necessary to verify future agreements.

Such a compromise will almost certainly encounter opposition at home and abroad. In pursuing missile negotiations, one important objective will be to assure allies that their interests are also being safeguarded. It is quite possible that some in Tokyo would view deferring a deployment ban on missiles that threaten Japan as contrary to its security interests. Critics in the United States will chime in as well, viewing such a step as unnecessarily, placing our key ally, and perhaps US forces stationed in Japan, at risk.

One important consideration in fashioning this compromise will be the status of negotiations on denuclearization and whether the combination of steps taken on both fronts will make it more difficult for North Korea to mount nuclear weapons on its missiles. Most experts believe that North Korea will require more nuclear tests to miniaturize its design sufficiently for mounting on missiles. A nuclear test moratorium—or a more permanent ban on testing—would probably prevent the North from doing so. Other denuclearization measures, such as preventing the further production of plutonium or halting the uranium enrichment program short of developing weapons grade material would also limit the danger of missiles carrying nuclear warheads.

*Space Cooperation*

The first phase of space cooperation is likely to require the provision of alternative space launch services for the DPRK in view of the ban on developing its own long-range systems and the beginning of a sustained, hopefully accelerating, effort to help the DPRK establish a viable peaceful space program through regional and international cooperation. On the first count, giving up a capability in large rockets is a rare, but not unknown event. For example, South Africa gave up its space launch capabilities as part of a broader political realignment in the early 1990s. In 1993, the United States provided an Orbital Science Pegasus vehicle to Brazil for a satellite launch after that country transitioned to a democratic civilian government and agreed to cease its efforts to build nuclear weapons and long-range missile delivery systems.

The obvious sources of launch services for the DPRK would be China or Russia as the lowest cost providers that could work with the North Koreans. Moreover, Russia has a diverse range of vehicles and experiences in launching small satellites for international customers. (Use of a Japanese or a ROK launcher would likely be politically impossible until later phases of cooperation.) Dedicated launch vehicles, even Russian or Chinese ones, can cost tens of millions of dollars. But a full launch vehicle need not be dedicated to a single payload. Given the North's limited capabilities, a DPRK satellite could be very small and launched as a secondary payload in conjunction with a larger primary payload. Providing a few secondary payload opportunities per year would seem to be more than enough for a near-term DPRK space effort. Micro-satellites are capable of performing almost every function that might be found in larger satellites save those that are limited by engineering requirements (e.g., functions requiring physically large antennas or optics). They can relay communications, take scientific measurements, observe the Earth and carry small experiments into the space environment.

Aside from the provision of launch services, a key objective for Phase 1 of peaceful space cooperation will be to engage the North in multilateral and bilateral discussions focusing on building institutional capacities and identifying potential avenues of cooperation. These initial seminars and exchanges will help identify key DPRK personnel, their level of technical and political sophistication, as well as foreign language abilities (a serious consideration in building cooperation in view of past problems in incorporating Russia into the International Space Station and likely future difficulties in cooperation with China). Examples include:

- **Attendance at United Nations space-related regional meetings and International Telecommunication Union and Asia-Pacific Tele-community seminars.** In the case of the United Nations Office of Outer Space Affairs (OOSA), there are Regional Centers for Space Science and Technology Education, of which, one is located in Asia (New Delhi) and was created in 1995. The DPRK joined the cooperation agreement in 1996, but has not been an active participant. The Center in India offers training in space science, atmospheric science, remote sensing, geographic information systems, satellite-based meteorology, satellite communications and global positioning system applications.

  Similarly, the ITU, of which the DPRK is also a member, holds regional training programs for developing countries, including those in the Asia-Pacific region. This training deals primarily with the international regulation of spectrum (ITU-R) while smaller portions deal with telecommunication standards (ITU-T) and the needs of developing countries (ITU-D). The ITU groups countries into Region 1 (Europe/Africa), Region 2 (North/South America) and Region 3 (Asia-Pacific), and includes the DPRK as a member of the Asia-Pacific Tele-community (APT), which is a coordination group of national spectrum management administrations. As with OOSA, the DPRK is not active in the ITU as a whole, although it joined the APT in 1994. An ITU-D program in "human capacity building" was held in the DPRK in 2009 out of a dozen or so efforts elsewhere in the region. Such programs typically deal with regulatory training in spectrum management and applications of new technologies such as rural broadband and mobile wireless.

- **Invitation to APEC meetings on special topics such as satellite-based navigation.** While the DPRK is not a member of APEC and there is currently a "moratorium" on the admission of new countries, North Korea could be invited as an observer to specialized activities such as the APEC Global Navigation Satellite Systems (GNSS) Implementation Team that is concerned with the use of systems like GPS for transportation safety and security. Primarily focused on air traffic management, satellite-based navigation is useful in all modes of transportation, such as rail, trucking and shipping. Meetings of the Implementation Team consist of governmental and industry experts making recommendations on how APEC economies can most effectively implement satellite-based navigation systems for their own benefit. Recent activities include regional test beds funded by the United States to evaluate GNSS augmentation capabilities in the region, collect empirical data on GNSS performance, allow participating economies to attain hands-on working experiences with GNSS equipment, enable validation of GNSS performance over their Flight Information Regions (FIR) and establish a stage for regional research collaboration. The practical benefits of improving transportation efficiency with satellite navigation could be an important opportunity for cooperation with the DPRK, building ties not only with APEC members but also facilitating engagement with specialized UN agencies such as the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) where satellite navigation is a commonly used and understood technology.

- **Multilateral seminars in space law and legal capacity building.** The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has a legal subcommittee that in 2007 adopted an agenda item on "capacity building" in space law. As developing countries make greater use of space technology, they will need to have greater legal capacities in terms of domestic regulations and institutions, and adherence to international treaties, agreements and principles. This will require trained manpower and thus a need for specialized educational programs. The UN has conducted workshops in space law as part of promoting the adoption of and adherence to international space treaties (e.g. the 1967 Outer Space Treaty). The most recent was held in Tehran, Iran in November 2009, which demonstrated that being subject to international sanctions was not a barrier to space-related discussions. In November 2003, a space law workshop held in the South Korean city of Daejeon attracted about 100 participants from 27 countries, but none from the DPRK. Attendees included a wide range of legislators, government officials, private sector lawyers and educators. Participation of DPRK representatives would allow for a wide-ranging exchange of views not only on legal issues, but also on how governmental institutions interact with each other and how they might interact internationally.

Building on these initial exchanges, more substantive efforts would then focus on tours of DPRK facilities by foreign technical experts. The initial exchanges should create a common baseline understanding among participants as to the state of DPRK technical and managerial capabilities to participate in and manage space projects. In the course of these exchanges, a major goal will be to determine how much truly indigenous development capability the DPRK possesses. This will require tours of DPRK facilities and assessments by technical experts just as occurred in the initial stages of US-Russian space cooperation and as are occurring now in explorations of potential US-Chinese cooperation.

Further acceleration of cooperation might entail DPRK participation in the China-led Asia-Pacific Space Cooperation Organization (APSCO) projects such as its effort to build a series of Small Multilateral Mission Satellites (SMMS) with optical sensors in multiple bands for purposes of environmental and disaster monitoring. Of course, there may be dual-use applications of the same technologies and data that would motivate DPRK interests as well. Nonetheless, including the DPRK in an existing project under Chinese leadership would also increase its interactions with APSCO members such as Bangladesh, Mongolia, Peru, Thailand, Pakistan and (perhaps) Iran.

If there was a political decision to rapidly accelerate space cooperation, then direct engagement on a micro-satellite project would be possible. In building a space program for a developing country, the first step is to identify or create a basic scientific and technical capability ("centers of excellence"), followed by legal structures and management processes to make international agreements possible. This could then be followed by support for basic science (e.g., astronomy) and ground-based exploitation of space applications, (e.g., remote sensing, weather and geographic information systems). With this foundation, the DPRK could build very small satellites (a.k.a. "cubesats" or micro-satellites) that could be flown as secondary payloads. Amateurs, universities and developing countries use small satellites as a way of training themselves in satellite technology and as a precursor to owning and operating larger, more complex systems. Many countries, ranging from South Korea and South Africa to Vietnam and Sri Lanka, have launched or are working to launch very small satellites as secondary payloads to larger missions. Ideally, this step would build on the kind of prior experiences described above which might be completed in one to two years if legal and organizational capacity building proceeds in parallel.

Such a satellite could be built in the DPRK but put into space on a foreign launcher. This could be a highly visible, albeit modest, project that would have minimal proliferation and technology transfer risks. The necessary technical skills in materials, electronics, software and an understanding of the space environment should be well within the capabilities of the DPRK. It would give the North some experience in working with other countries on space hardware and an internationally accepted spacecraft in orbit. On the other hand, such a project would do little to train DRPK personnel in practical applications of space technology, processing of data from space, construction of advanced scientific instruments or even the legal skills for international commercial cooperation (e.g., satellite communication). This program would essentially be a proof-of-concept demonstration that the DPRK is interested in having a civil space program and could be pursued in cooperation with other countries, for example, China or Russia who could provide the actual launch services.

In Phase 1 of space cooperation, the cost to the international community for seminars and exchanges would be relatively modest. The largest costs would likely be those associated with launch services, but even those could be modest if the launches were for micro-satellites as secondary payloads. Even if the DPRK were to insist on parity with a launch capacity equivalent to the Taepodong-2 (about 100 kg), the costs would be the same as for a micro-satellite.[26] If the DPRK were to seek a dedicated launch vehicle or launching a larger payload (say, over 500 kg) then the high cost could likely be unacceptable in Phases 1 or 2.

Still, the modest direct costs for initial phases of space cooperation can be misleading as there may be considerable, related expenses that would need to be absorbed by a threat reduction program. For example, if the DPRK were to stop its long-range missile testing and development, a first consideration will be what to do with the technical experts (e.g., scientists, designers, engineers and technicians) now made redundant. Some experts will have skills that are not easily transferable to other activities and a specific home will be needed for them. A DPRK space program could be a potential option for many managers, scientists, engineers and technicians. Scientists could be diverted to academic teaching and research at existing institutions or new research centers with international participation. If there are specialized experts who enable an indigenous DPRK space launching capability and they cannot be transferred to other pursuits, then direct support will be needed for those individuals.

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26 David Wright, "An Analysis of North Korea's Unha-2 Launch Vehicle," Union of Concerned Scientists, March 18, 2009. http://www.ucsusa.org/nuclear_weapons_and_global_security/missile_defense/technical_issues/an-analysis-of-north-koreas.html.

*Cooperative Threat Reduction*

Cooperative threat reduction initiatives would be structured to support arms reduction and space cooperation discussions, to build mutual confidence among the parties and to influence DPRK actions such that it becomes more difficult for the North to reverse direction on its ballistic missile commitments, an important consideration given concerns about Pyongyang's past behavior. In that context, the most important priority will be to quickly establish the basis for redirecting workers from shut down factories, along with the conversion of those facilities, laying the groundwork for the presumably more extensive measures in the next phase of limitations, which will focus on rolling back the program.

*Joint Seminars*

A simple first step would be to organize joint seminars involving experts and appropriate officials from the DPRK and other parties. Such seminars could begin the process of sharing experiences and exchanging ideas at a working level, with the goal of identifying possible cooperative activities that could build a foundation for future phases. These seminars would also begin building a network of key individuals on both sides—through personal contact and familiarity—who would hopefully continue to be involved as the DPRK missile discussions move forward.

A high priority for these seminars will be to explore avenues of non-missile/non-military activities for DPRK missile facilities and personnel. The seminars could identify feasible measures for the very initial stages of cooperation and lead to joint studies, assessments, tasks and plans. The purpose would be to evaluate the effectiveness (and ultimately, the political acceptability) of proposed joint activities, methods and techniques to be applied to negotiated agreements.

In previous CTR experiences, there were a variety of measures pursued, most of them tailored to address a unique situation. For example, on employing former weapons scientists, the two multilateral Science Centers were established for the former Soviet Union situation, while smaller, more tailored programs were used for the Iraqi ex-WMD scientists and for the Libyan scientist engagement initiatives. Thus, these first joint seminars could expose any obstacles to further cooperation and provide guidance for pursuing specific DPRK cooperative initiatives where consensus support is found.

A Phase 1 agreement to end DPRK ballistic missile exports and ban long-range ballistic missile tests might consider relevant seminar topics include:

- **Redirecting ballistic missile production infrastructure to non-military activities.** Such seminars would discuss initiatives designed to address the loss of work due to a negotiated ban on ballistic missile exports. Some topics could be: 1) exchanging experiences in converting former missile production to non-missile production, with some examples provided by Russian and Ukrainian experiences; 2) introducing the general science and technology capabilities, technology base and R&D directions of the DPRK missile complex—perhaps limited to that part of the complex affected by an export ban; and 3) exploring potential non-military applications for ballistic missile research, development, engineering and production assets.

- **Transitioning long-range missile test assets to new research directions.** A flight test ban would probably affect not only production assets dedicated to building DPRK flight test missiles, but also personnel responsible for research, development, test and evaluation processes. To address the loss of work for this group of flight test specialists, seminars might be organized introducing: 1) the level of experience, strengths and needs of the DPRK scientific and research capacity, with special attention to possibly using this experience in a non-weapons, academic research environment; 2) the level of expertise in flight technicians and systems engineers, with consideration on non-military applications of these specialized skills and work experience.

- **Confidence building in cooperative verification and monitoring measures.** Similar to the joint arms control verification experiments and technical demonstrations performed between the United States and the Soviet Union during the 1980s, there probably will be a great need to introduce and discuss various monitoring and verification measures that might be called for under the Phase 1 arms reduction track. Seminars could be used to share experiences on past cooperative monitoring and verification measures and to introduce and explore possible new technologies and procedures. While this theme might sound more appropriate for arms reduction negotiations, many aspects of cooperative missile reduction will need to mutually support the arms negotiations (and the space cooperation track). Success in any of the three tracks will depend on the depth of confidence and spirit of cooperation with the North Koreans. Thus, initiating working-level discussions via workshops, seminars or similar forums can be a critical beginning step in the process of building the necessary levels of trust and confidence in the whole endeavor.

*Planning Workshops*

If the pace of negotiations is faster than expected, there may be a need to skip preliminary seminars and start right off with specific project planning. These workshops would be smaller than seminars and include participants whose expertise or official position would be appropriate to designing and planning specific DPRK missile reduction initiatives. The experts and officials would be drawn from the North's missile complex, from foreign participants in past CTR programs and other aerospace and rocketry experts.

If Phase 1 includes a ban on missile exports, a workshop for redirecting DPRK missile production assets will become an urgent priority. Based on past experience, one possible rapid redirection project would be to spin off parts of the export missile complex into small organizations of component manufacturing that would engage personnel and facilities in transparent research and development work for civilian projects. For example, a DPRK production unit responsible for constructing missile engine turbo-pumps could be separated from the main production facility and established as a standalone unit tasked to produce turbines for new domestic hydroelectric generating plants (assuming construction of such plants is an important development program agreed to by the concerned parties). A workshop could be organized to develop plans for establishing such spin-off organizations. This workshop would determine the necessary legal documentation, the amount of the missile production assets that would be dedicated to these organizations, and what types of technical and administrative expertise would be required for the staff.

Another cooperative endeavor could be the physical conversion of certain missile production facilities to domestic, non-military production of commercial goods needed by the DPRK civil society (although there would be a need to consider how to ensure that the products were not being used to support DPRK military needs). Missile production halls could be converted to production of industrial machinery, agricultural machinery or transportation components such as railway engines and railcars.

In the case of Russia, as Moscow began reducing its strategic nuclear warhead inventory under the first START agreement, the Avangard Warhead Assembly/Disassembly facility in the closed Russian nuclear city of Sarov became underutilized. As an incentive to the Russian Federation, to the city of Sarov and to the soon-to-be-underemployed nuclear warhead technicians, the US Department of Energy worked with the Russian government and local city officials to convert floor space within the Avangard facility to produce medical equipment and related components.[27] This conversion to non-military, commercial production not only relieved Russia of a burden that might have impeded its nuclear warhead reduction process, but also provided some confidence among the cooperating parties that the excess, military-related infrastructure had been converted to non-military use.

A critical consideration will be the need for transparency and steps that make reverting to missile production extremely difficult or impossible. During Soviet times, missile production complexes in Ukraine received state orders to also produce farm tractors, light railcars and other types of civilian-sector machinery. The production halls were geared so that some assembly lines could build missiles and others civilian machinery. Today, there are political, legal and commercial incentives that deter the Ukrainian rocket complexes from shifting their commercial lines back to ballistic missile production. But in the DPRK case, there might be a greater need to ensure that such reconfiguration capability is restricted to the greatest extent possible. So, any conversion of DPRK missile production facilities would have to take into account certain physical plant changes (such as reconfiguring assembly line apparatuses, jigs, etc.) that would make the ongoing operations clear and transparent and would restrict the “dual-use” character of the production lines, making it difficult to openly (or secretly) change the line back to missile production.

Another avenue to build transparency would be to limit work at these new organizations and facilities to producing equipment for bilateral and multilateral development assistance projects created specifically in connection with these missile negotiations (or other negotiation tracks). In this way, there would be outside personnel or institutions involved in these DPRK civil development projects that would include the “spin-off” missile organizations. Facilities and personnel formally producing export missile components could be captured in producing components for all types of joint civil development projects inside the DPRK (e.g., improved electrical generation/distribution systems, new and safer industrial chemical plants, new water purification systems, etc.).

Aside from the conversion of production facilities, additional consideration will have to be given to the different categories of production-related personnel. For those involved in general construction—machinists, welders, etc.—their skills are common enough to be used directly in other industrial activities inside the DPRK. Therefore, organizing a specific cooperative engagement effort for these general workers does not seem necessary. For more specialized workers—engineers, technicians, specialized equipment operators, etc.—a more concentrated effort would be needed to create cooperative efforts that engage their specific skill sets in non-missile production work (e.g., designing and producing components such as turbo-pumps and cylindrical piping for new hydroelectric generator systems, or oil or water pipeline networks, etc.).

A ban on long-range missile flight tests would affect not only missile production personnel, but also the scientists, technicians and design engineers that are responsible for analyzing flight data and evaluating design performance modifications. For these individuals, a more scientifically sophisticated redirection

27 Michael Wines, “Energy Secretary Visits Russia,” *New York Times,* August 31, 2000.

approach is needed. In conjunction with the Phase 1 space cooperation track, a workshop could be organized to develop plans for creating academic centers of aerospace research and cooperation that would engage these design-level DPRK experts with other peers in pursuit of peaceful space research and exploration topics. These centers could serve as focal points for improvement of DPRK higher educational capacity, but also as central coordination points for North Korean cooperation with regional or international space cooperation groupings.

The centers would have to be accessible and focused on basic research work with the active involvement of foreign collaborators. The stakeholders of these open centers could also seek willing donors to sponsor symposia in order to promote scientific engagement with the DPRK. The centers could host cooperative programs designed to prepare the DPRK scientists to present their current research and to help them in developing possible collaborations for joint science projects that could be financed by ex-weapons scientist engagement programs or by other academic grant foundations under strict oversight guidelines to minimize their possible dual-use aspects. The centers could be coupled to the steps taken in the space cooperation track, so that some workshops would be designing activities to dovetail with the space cooperation efforts. Not all of the centers' work will need to be "space cooperation" related, but a fair part of their activities probably could assist that track.

One key goal of the new centers will be to draw DPRK missile scientists away from the missile complex in terms of intellectual presence. An even more desirable objective would be to establish open, accessible research centers either on the territory of or in very close proximity to the missile R&D facilities themselves. Here, past CTR initiatives may provide useful experiences, such as the Open Computing Centers established at two Russian nuclear weapon design laboratories (Snezhinsk and Sarov) created with program support from the US Department of Energy.[28] These centers allowed ex-nuclear weapons scientists to work on computational tasks and software development, while the open center provided a small area of transparency and accessibility near the nuclear weapons R&D facilities.

## Phase 2

*Arms Reduction*

The principal arms reduction measure in this phase will be the beginning of the elimination of all ballistic missiles with ranges over 300 km. One approach that would satisfy DPRK requirements to maintain a residual force for security requirements while initially limiting the threat posed by those weapons would be to begin this process by first freezing the production of missiles in this category. That in turn would also serve to reinforce the ban on exports initiated in the first phase of this strategy and create an outer bound on the DPRK inventory of these weapons.

While a complete ban on the production of missiles able to fly 300 km would prove easier to verify than an interim freeze, the latter might be unattainable at the outset of this process (a ban would require the

28 For a description on the Open Computing Center in Sarov, Russian Federation, see, *inter alia*, Judith Miller, "U.S. and Russia Find a Home for Disputed IBM Computers," *New York Times*, October 1, 1999. For a description on the Open Computing Center in Snezhinsk, see "Former 'Nuclear City' Opens Non-Weapons Computer Center," US Department of Energy Press Release, November 20, 2000.

dismantlement of production and assembly facilities). Initially, North Korea would be required to declare production and assembly facilities associated with prohibited missile systems. Based on the experience of the INF and START treaties, verifying a cut-off would then require North Korea to institute "perimeter portal monitoring" at those facilities to allow remote confirmation of items leaving those factories to ensure they had stopped production of proscribed systems.

There are a number of added complications in the case of North Korea. The United States may find it difficult to verify the non-production of Nodong and Taepodong missiles since they are derived from Scud technology found in missiles not banned under this arrangement, without elimination of the Scud production infrastructure. If North Korea continued to produce shorter-range Scuds, then all production and final assembly plants also would need to be subject to continuous portal monitoring to assure that the production ban on prohibited types is verifiable. The United States would also require the right to conduct short-notice inspections at other sites that come under suspicion of being used for final assembly.

UNMOVIC, after its experience in Iraq, drew the conclusion that liquid-fueled missile programs are the most likely candidate for range-extension.[29] UNMOVIC discovered that assessing the range of missiles under development is complicated. Limiting Iraq's missile development required additional technical parameters beyond range. UNMOVIC used a variety of tools, including regular declarations, on-site inspections, static and test flight observation, remote cameras, inventorying of equipment and tools, document and computer searches and tagging of missile hardware—a level of access that North Korea is unlikely to provide.[30] Recreating the UNMOVIC experience in North Korea seems neither feasible nor desirable.

Many analysts believe that North Korea's ballistic missile program is far less indigenous than has been assumed in the past and that Pyongyang essentially performs kit assembly on missiles that are imported in component form, probably from Russia. If this is even partly true—and the evidence is most suggestive regarding the Musudan—this may pose an additional problem. North Korea may be reluctant to reveal the degree of foreign assistance and implicate Russian firms.

Much more than verification would be at issue in such a freeze. As with any measure that falls short of banning delivery systems able to strike targets in their countries, there will be anxiety in Seoul and Tokyo that such an agreement would still leave South Korea and Japan vulnerable to North Korean ballistic missiles. As a result, an agreement that captures the Nodong and Taepodong that threaten the United States and its forces abroad, but not missiles that can strike South Korean and Japanese territory may be politically unacceptable. At the same time, getting such a ban without reciprocal limits on South Korean and Japanese missiles may be more difficult. Nevertheless, it could be argued that this arrangement, by bounding the North Korean threat and beginning a process of reduction would serve US security interests, as well as those of its allies.

The Toksa solid-fueled ballistic missile poses this problem in a particularly pernicious way. An agreement that did not address North Korea's Toksa inventory might be vulnerable to charges that it failed to constrain a significant North Korean capability. One option would be to institute a lower range limit that

29 United Nations Monitoring, Verification and Inspection Commission, Note by the Secretary-General, United Nations Security Council document S/2005/351, May 27, 2005, 15.
30 United Nations Monitoring, Verification and Inspection Commission, Note by the Secretary-General, United Nations Security Council document S/2006/420, June 21, 2006, 55-56.

would capture the Toksa, such as a 150 km threshold with additional technical parameters comparable to those imposed on Iraq.

The major difficulty with an Iraq-like limitation, in contrast to an MTCR limit, is that South Korea is believed to be developing cruise and ballistic missiles with ranges in excess of 110 km. An agreement with the United States prohibits South Korea from fielding a ballistic missile with a range over 150 km, but Seoul has been seeking to revise that arrangement. Kim Jong Il expressed North Korea's willingness in 2000 to join the MTCR as part of any arrangement, but only if South Korea also acceded to the regime. North Korea is likely to insist on reciprocity with South Korea, suggesting that resolution of this issue might be better put off in a separate agreement at a later date. Moreover, Washington should resist efforts by Seoul to renegotiate the range limits on its missiles in the meantime. A second option, as an interim solution, would be to build confidence through a limited monitoring regime that North Korea was not attempting to use the Toksa program to support an effort to build a 300 km solid-fueled ballistic missile.

*Interim Numerical Limits on Missiles with Ranges Over 300 Km*

While freezing production would establish an indirect cap on total missile inventories and establish specific interim numerical limits on missile inventories, building on the historical experience of the START and INF Treaties might serve as an important step towards elimination. First, it would directly limit the inventory of missiles, establishing a baseline for the eventual elimination process. Second, within that context, placing limits on deployed missiles could serve as an important confidence building measure, bounding the threat posed by mobile missiles in peacetime and enhancing stability in case of a crisis by establishing an important political barrier that could prevent the deployment of additional threatening mobile systems.

North Korea would be required to take a number of steps to assist the monitoring process. First, Pyongyang would have to provide a declaration of the total number and type of missiles in its inventory, along with their locations and the facilities associated with the production of the proscribed missiles. This is likely to be relatively complicated. For example, Iraq's declaration regarding missile activities exceeded 2,500 pages not including supporting documentation. Second, US experts will have to conduct on-site measures to confirm the declaration. This will also require visits to sites where missile systems are located.

An additional layer of limitations focusing on deployed systems would pose a number of verification challenges that would also require Pyongyang's cooperation. First, limiting missiles rather than a total ban would be more complicated because the number of missiles would be more difficult to monitor than detecting a single system. Indeed, it is not clear whether US intelligence has ever detected deployed Nodong or Taepodong missiles or their launchers, except for those at test-launch sites. A number of cooperative transparency measures on the model of the START and INF Treaties would be needed to help preclude any militarily significant violations. Agreed over-flights by reconnaissance aircraft might also facilitate verification.

Aside from a complete declaration of the types and numbers of missiles in Pyongyang's inventory, a second cooperative measure would be the "fencing in" of missiles in patrol or deployment zones. This transparency measure would be easier to monitor than an agreement, and in any case, liquid-fueled missiles cannot roam freely for extended periods of time. They have to be tethered to base in order to permit fueling prior to launch. Moreover, off-road mobility is also likely to be limited: such systems cannot move very fast, even on paved roads, without risking their reliability. However, relocation far afield from their bases, for instance for repair, would pose a problem for counting without a provision for prior notification.

A third transparency measure would be periodic "parades" to facilitate counting by NTM. This would involve displaying missiles at or near their operating bases, one base at a time, to avoid exposing the force to simultaneous attack. Article VIII of the 1987 INF Treaty could serve as a template for these arrangements. The US would have the right to request a specified number of parades. On six hours' notice, the North would be required to remove all the missiles at a given base from concealment and display them out in the open for a set time period.

Collocation of short-range missiles at the same base might also be problematic if their launchers were indistinguishable and could be used to launch medium or longer-range missiles. Technical provisions that would help national technical means in distinguishing missile types could prove helpful in dealing with this potential problem.

*Space Cooperation*

This phase would build on the previous cooperation measures and develop the technical, organizational and political foundations for moving into the next phase. It might also include steps such as the beginning of limited space cooperation between North and South Korea. Assuming Phase 1 has gone well and that the DPRK has acceded to UN space treaties, has complied with relevant Security Council resolutions and has created mutually acceptable points of contact for civil space cooperation, cooperation could include:

- More extensive training in geographic information systems and the use of commercial remote sensing data. This could include applications in agriculture, mapping, weather, civil construction and disaster management.
- Contributions of English and Korean language scientific reference works to DPRK universities, including limited electronic subscriptions to select scholarly journals.
- Increased satellite communications capacity for the DPRK, including both fixed and mobile satellite services from commercial providers (e.g., Inmarsat, Iridium).
- Scientific data exchange on climate change in cooperation with South Korea as part of GEOSS and UN-SPIDER.[31]
- Date exchanges and participation in multilateral disaster monitoring such as Sentinel Asia.[32]
- Improved DPRK weather data exchanges with members of the World Meteorological Organization (WMO) to include analytical support for images from polar and geosynchronous

31 See the United Nations Platform for Space-based Information for Disaster Management and Emergency Response—UN-SPIDER. http://www.un-spider.org/.
32 Sentinel Asia is a voluntary initiative in disaster management led by the Asia-Pacific Regional Space Agency Forum (APRSAF) for the Asia-Pacific region.

weather satellites.

- Radiosondes and DPRK experiments on foreign sounding rockets. This would be limited to only those facilities open to international participation.

Successfully completing these kinds of exchanges will depend on both technical and organizational factors, particularly the participation of trained experts who understand how to exchange scientific data and managers who are routinely authorized to permit and accept the exchanges. Interactions with international scientists and managers in turn help create networks and relationships that can be the starting point for more ambitious efforts. Essentially, these steps seek to train DPRK organizations and people on the norms and practical benefits of civil space cooperation.

In addition, during Phase 2, more tangible space cooperation programs could include:

- Provision of an authorized LANDSAT receiving station, as well as modern Geostationary Operational Environmental Satellites (GOES) and Polar Orbiting Environment Satellite (POES) weather satellite receiving stations.

- Provision of National Oceanic and Atmospheric Administration (NOAA) Advanced High Resolution Radiometer (AVHRR) data from its POES.

The DPRK already receives limited space-based meteorological data from Chinese weather satellites in geosynchronous and polar orbits. The China Meteorological Administration operates the "FENGYUN Satellite Data Cast System" (FENGYUNCast) that distributes remote sensing data in China and nearby countries, including North Korea. The system uses the Asiasat-4 communications satellite to rebroadcast data provided by a central facility in Beijing as opposed to allowing direct satellite reception. This simplifies the reception requirements that can be met by commercially available personal computers running software provided by China. The system can also handle NOAA AVHRR data and is already part of international environmental data exchanges with Europe and the Americas.

Technical assistance, provided by China or perhaps other countries such as South Korea, would likely be necessary to train DPRK operators in the use of LANDSAT and AVHRR data sets. (There have been unconfirmed reports of a "pirate" LANDSAT station in the North.) Images could be acquired from the Chinese LANDSAT or other civil government systems, and there are an increasing number of commercial remote sensing firms from whom data could also be purchased. However, a domestic ground station and the ability to acquire and exploit such imagery for civilian purposes would be a significant foundation for a DPRK space program. The ground station itself is not that sophisticated, but the practical exploitation of the data would create opportunities for international scientific cooperation, as well as contribute to national development. The provision of a ground station would also be an important symbol of international acceptance.

AVHRR data, which represents measurements of energy reflected from the Earth, is used primarily to monitor clouds and thermal emissions (cooling) of the Earth. These data sets are useful in a number of scientific applications such as measuring land use, ocean states and atmospheric aerosols as part of climate change measurements. The latter application is particularly useful due to the availability of long-term data sets (e.g., over 20 years) with which to make comparisons. AVHRR data is not sensitive and is widely used by developing countries for basic remote sensing and meteorology tasks. For example, the United Nations Environment Programme (UNEP) has used AVHRR data in cooperation with local scientists for land cover studies in Bangladesh, Cambodia, Lao P.D.R., Myanmar, Nepal and Vietnam.

Unfortunately, it has been almost two decades since the last UNEP report was issued on the state of the DPRK environment.[33] In that report, the authors noted DPRK environmental challenges resulting from deforestation, declining water quality in rivers and streams from industrial pollution and increasing air pollution due to a heavy reliance on coal power sources. In that context, it is possible to imagine several fruitful environmental research projects on the Korean peninsula involving North and South Korea with space data support from China, Japan and the United States.

*Cooperative Threat Reduction*

Much of the Phase 2 cooperative missile reduction activity would also involve implementing promising initiatives already underway. Beyond continuation of Phase 1 cooperative missile reduction activities, if the political environment has sufficiently improved it might also be possible to initiate more substantial initiatives:

- **Converting ex-ballistic missile resources to civilian activities.** One possible area where more intensive cooperative work could take place is in evaluating the capability and willingness of the DPRK to engage more of its missile production capacity in open, civilian activities, some commercial. Seminar and workshop exchanges could be organized to explore the commercialization of DPRK science and technology. In Ukraine, and other former Soviet states, cooperative engagement programs discovered that ex-missile scientists and technicians had little pre-existing entrepreneurial spirit, no experience in promoting their R&D capabilities and no culture of thinking about the long-term possibilities to maximize the civilian uses of their work. Thus, as was done by CTR programs in Ukraine and other FSU states, some of the Phase 2 seminars/workshops could be training sessions for DPRK scientists, technicians and managers on best project management practices, strategic planning techniques, concepts of technology transfer and dealing with commercial customers. This might be a stretch of the imagination, given the clash of the DPRK political culture and philosophies with market practices and norms. But if initial seminars from Phase 1 reveal some potential ground for cooperative training in these commercialization fields, Phase 2 cooperation could be an opportunity to start the long process of introducing DPRK ex-missile personnel to the beneficial exploitation of their skills.

- **Establishing open academic centers for aerospace research.** Another possible activity could be to follow-up on Phase 1 workshops by establishing academic centers of aerospace research, staffed with DPRK missile designers and engineering specialists. Many substantive issues will likely need to be carefully addressed in this effort, such as their management and staffing and physical location, as well as affiliations with DPRK academic institutions and external institutions. It will also be an opportunity to incorporate new partners in the cooperative missile reduction effort, such as universities and education institutions, private foundations interested in promoting higher education or academic research, and international organizations such as UNESCO.

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33 United Nations Environment Programme, “State of the Environment—DPR Korea,” Regional Resource Centre for Asia and the Pacific, 2003.

These DPRK academic centers could also serve as the central organizing points for collaborative science and technology research projects in fundamental aerospace topics. Similar to a role played by the STCU for Ukrainian ex-missile scientists, a program of sponsored, restricted research grant competitions could be organized and managed by these academic centers, with selected governmental or non-governmental programs providing the financial support and some of the peer review expertise. As with STCU and Ukrainian ex-missile scientists, such collaborative science research projects can facilitate a process of interaction and integration of former North Korean missile scientists into the international science community. The centers could also serve as a central point for organized training seminars in writing research proposals for competitive review and selection (something that was new for Ukraine's ex-military scientists when STCU began in the mid-1990s).

Further, the centers could become an organizational catalyst for regional or international science symposiums on aerospace science topics. These sponsored scientific symposia could be designed as a regular event, hosted on a rotating basis throughout the East Asian region, so that there would be opportunities for North Korean scientists to make scientific presentations, as well as create opportunities to publish their research work. Such interactions could raise problems with the DPRK government, given its internal security culture. But the initial symposia (plus other socializing programs first implemented through the new research centers) could facilitate the creation of a mutually acceptable framework for DPRK participation in external space cooperation associations, as well as assist in establishing their membership in these associations and in exploring acceptable and useful research directions for joint collaborative projects.

These collaborative science research projects would need to be carefully overseen by the non-DPRK parties involved. The DPRK academic centers, and the collaborative science research itself, must operate such that the risk of dual-use technology transfer or knowledge transfer is mitigated. The academic centers and their research work should be open to foreign collaborators and to technical and financial inspections by the donor programs. These same requirements are imposed by the STCU on its collaborative science projects with Ukrainian scientists, and while the DPRK governmental agencies might balk at such intrusiveness, a measure of outside oversight is absolutely essential to ensure political confidence in this particular initiative.

- **Engagement on global security topics.** Phase 2 might also provide an opportunity to start integrating the North more fully into the international security and nonproliferation regimes with cooperative seminars, workshops, and perhaps other, more tailored activities organized in the area of missile nonproliferation. For example, one seminar could focus on adapting the DPRK export control regime to international norms on missile technology transfers. Perhaps other areas of regional and global security interest could be open to cooperative measures (e.g., travel support to attend regional/international nonproliferation meetings or organizing such meetings to take place in the DPRK). Such cooperative missile reduction initiatives would depend on the North's accession and adherence to international nonproliferation agreements and export control arrangements. But if the DPRK showed such political willingness to adhere to international norms, cooperative missile reduction activities could be used to encourage and strengthen it.

Finally, there may be other ways that the Phase 2 CTR programs could support space cooperation, through travel, training or material support to DPRK participation in regional or international space cooperation groups. Also, cooperative missile reduction activities could be tailored to lend supplementary support for Phase 2 space cooperation initiatives, such as design and engineering projects supporting the installation and operation of space ground stations in the DPRK.

Expanding monitoring and verification measures to more missile production facilities or to phased reductions of deployed ballistic missiles will be a complicated Phase 2 arms reduction negotiation, particularly given presumed objections from the DPRK to intrusive verification measures. Phase 2 cooperative missile reduction measures could help negotiations by continuing confidence building through organizing joint experiments, training sessions and trial runs of verification proposals, as well as by providing some opportunities to engage the DPRK missile production facilities and interact with missile production personnel. While cooperative engagement measures will never be a substitute for verification measures, because of the partnership atmosphere underlying these activities, past threat reduction programs have provided indirect access to locations where intrusive verification measures were lacking (or were under negotiation). Thus, cooperative initiatives engaging DPRK missile production sites offer at least a chance to gain insights into the situation at these sites, as well as to build familiarity and confidence among the parties for pursuing the more direct verification measures.

## Phase 3

Ideally, this roadmap should end with the elimination of all DPRK missiles with ranges of 300 km or more, but it is uncertain whether negotiations can progress that far given the increasing overlap with conventional military missions. Political context will be critical, particularly if permanent peace arrangements on the peninsula have been reached and conventional force reductions put in place on both sides of the DMZ. Under those circumstances, it might even be possible to further lower range limits to capture all missiles, including the Toksa, except the shortest-range battlefield weapons. Given the reality that strict limits on North Korea's ballistic missiles are almost certainly going to capture relevant South Korean systems, it might also be possible to fashion a peninsula-wide ban on designated delivery systems.

Abandoning DPRK missiles with ranges over 300 km would require:

- **Ban on missiles with ranges of 300 km or greater.** The missiles and their associated support equipment, first identified in Phase 2, would be dismantled at predetermined sites according to pre-set procedures and displayed in the open for a number of days to allow time for monitoring by national technical means. Missile operating bases and their support equipment would also be dismantled. Once they have been dismantled but before the parts had been removed, the US would be given 30 days' notice to allow for observation by national technical means. The INF Treaty, especially articles IX and X and the protocol on elimination provide suitable procedural precedents.

  A complete ban on deployed medium and long-range missiles would be easier to verify than numerical limits since any missile detected would be suspect. The problem would be to distinguish short-range missiles and their launchers from medium and long-range ones by their overall dimensions. Technical provisions to ensure that these missiles could be distinguished from banned weapons by national technical means might help with verification but there would still be a requirement for on-site inspections if any doubts remained. Additional measures, such as limits on areas where these missiles might be deployed could also prove useful.

- **Ban on production of missiles with ranges of 300 km or greater.** Facilities associated with the production of proscribed missiles would be dismantled or converted (see section on Cooperative Threat Reduction). This process, as well as an overall ban on production of these systems, would be monitored through a combination of NTM and on-site inspection. Effective verification may require continued on-site monitoring at still existing facilities that produce and assemble Scuds with ranges that fall below the 300 km range limit. The establishment of programs on the ground to convert facilities for civilian uses would hopefully help secure increasing access to North Korean factories.

*Space Cooperation*

If Phase 3 objectives are achieved—elimination of all missiles in excess of the MTCR limits (combined with denuclearization and compliance with the NPT)—then a full range of space cooperation will become feasible. Such cooperation might even include direct cooperation with the United States, even if not purely bilateral. If the DPRK has been successful in building up its civil space capacities, more ambitious cooperative space projects between North and South Korea may also be possible. This might include the launching of DPRK micro-satellites on ROK-provided vehicles, hosting of DPRK instruments on ROK scientific missions, joint analysis of data from international cooperative missions (e.g., climate monitoring, pollution impacts) and joint cooperation in using space systems for disaster mitigation (e.g., earthquakes, floods).

Assuming the DPRK has met its obligations and built up its civil space capacity, projects in this phase could include continuing efforts begun previously as well as:

1. Micro-satellite launched as a secondary payload
2. DPRK satellite deployed on a dedicated Chinese or Russian launcher
3. DPRK experiment flown on a Chinese Shenzhou space lab
4. DPRK-hosted payload on a Chinese or ROK satellite
5. Open international space science competitive grant programs to DPRK scientists
6. Flight of a DPRK astronaut to a future Chinese space station (post-2025)

As in Phases 1 and 2, launches would generally be provided by members of the Group of Six on a no-exchange of funds basis. If the DPRK space effort develops in a positive way, then a dedicated launch of a major payload—which could contribute to environmental and disaster monitoring, regional communications or scientific research and would benefit both the DPRK and the international community—could be contemplated although cost could be problem.[34] Dedicated launch vehicles are commercially available but they can be expensive even for small payloads. (Any launch paid for by the

34 As an example of support after a political breakthrough, the United States provided an Orbital Science's Pegasus vehicle for a Brazilian satellite launch in 1993. The airborne platform supported the launch from Brazil and then returned to the United States. The launch cooperation occurred after Brazil transitioned to a democratic civilian government.

US Government would have to go on an American launch vehicle.[35]) Moreover, it is unlikely that Russia would contribute a dedicated launch vehicle that might otherwise be used to earn foreign currency. As mentioned earlier, Japanese and ROK launchers would be politically problematic in early phases, but they may be possible in Phase 3. Thus Chinese launch vehicles may be the most likely choices in terms of cost and political acceptability.

In a similar vein, while the placement of a DPRK experiment aboard the International Space Station would not be possible, a small experiment could be flown on an independent Chinese manned space station. Beijing has plans for a 20-ton core module, two smaller research modules and cargo transport vehicles, all known as “Tiangong-3,” for the 2020 time period.[36] China might even consider flying a DPRK astronaut as a “guest taikonaut” just as the Soviet Union did for allied countries and Russia does today for paying customers as “space flight participants.”

These examples are distinct from the prior phases in that they are more richly symbolic and represent deeper levels of technical and organizational engagement with the DPRK. None of the projects would represent dramatically new levels of technical capability on the part of the DPRK, with the possible exception of its scientists competing for international scientific grants. Rather, they would demonstrate a normalization of the DPRK’s space activities on par with other developing countries in the Asia-Pacific region, a far cry from the present situation.

Recalling the list of space-related agreements and organizations from Table 1, it was noted that the DPRK did not belong to many of them and was not very active in the organizations it did belong to. In reviewing lists of global and regional conferences that have any relationship to space applications, the DPRK is less active than other less-developed countries in the region. This does not mean that membership or active participation should be treated as some sort of prerequisite for the DPRK. Save for accession to the major UN space-related treaties, there should not be a “check-the-box” requirement for the North to join these organizations as the phases of cooperation proceed. Instead, active participation should be seen as a lagging indicator of how well DPRK scientists are integrating (or not) into the international space community. Joining them is not like joining an international financial institution, as entry is relatively easy and open. While it might be an interesting curiosity the first few times a DPRK delegation appears at a space conference, the community will quickly determine whether they are there “for real” or just “for show.”

*Cooperative Threat Reduction*

Cooperative programs will build on existing missile reduction activities while offering new incentives for the DPRK to take more far-reaching arms reduction and elimination measures agreed to in this final stage. Simultaneously, growing cooperative reduction activities should further cement the notions of sufficient transparency, progressive and trusting interactions among the parties, and growing confidence in missile reduction commitments made in this phase.

Phase 3 should see the implementation of major infrastructure projects and expanded cooperative

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35 The DPRK would likely prefer a US launch for the propaganda value of the United States “supporting” a DPRK space mission.

36 Clara Moskowitz, “China Shifts Space Station Project Into Overdrive,” posted at SPACE.com, April 15, 2010. http://www.space.com/news/china-prepares-for-space-station-100415.html.

initiatives, building on the ideas and plans developed during the seminars and workshops of the prior phases. This expansion will likely include a greater number of multi-year projects that will require large investments in political support, time and effort, program oversight and monitoring (not to mention cost) in order to implement them successfully.

The Phase 3 cooperative missile reduction work will likely take on the appearance of the major US Department of Defense projects performed under the START framework and later in response to the breakup of the Soviet Union. In the early 1990s, much of the Department of Defense work focused on improving the infrastructure of the new states created out of the former Soviet Union to safely eliminate strategic offensive weapons (such as ballistic missiles), secure dangerous materials that could not be immediately destroyed and eliminate or convert the excess military support infrastructure (production facilities, operations and maintenance infrastructure, storage facilities, deployment sites, etc.).

Missile dismantlement will be a key activity during this phase based on the abundant experiences from former Soviet missile destruction projects. In Russia and Ukraine, liquid and solid propellant ICBM neutralization and elimination facilities were built on the territories of former missile facilities. All the benefits of CTR could be seen in these projects: converting portions of missile facilities in order to safely and securely destroy missiles; the cooperation and confidence created on all sides by working together to build these elimination facilities; and the programmatic and technical lessons learned from these efforts that could be extended to other cooperative projects. Based on this experience, US program expertise (and perhaps similar expertise from the former missile facilities of Russia and Ukraine) could be brought into the process of designing safe, efficient elimination processes for DPRK missiles, along with the DPRK's production and support infrastructure.

In addition, many Phase 2 activities would be continued even as ballistic missiles are being eliminated. In this phase, the cooperative missile reduction activities should begin focusing on a few long-term Phase 2 initiatives that move the remaining DPRK ballistic missile infrastructure towards permanent elimination or towards conversion to peaceful activities (e.g., weapons scientist redirection). There could be continued support for developing the DPRK aerospace academic centers, facilitating further integration into aerospace science and technology associations and international aerospace programs and developing the DPRK's cooperative activities in other scientific fields, as well as the global stability/security arenas.

Also at this point, some of the DPRK missile infrastructure converted under the previous phases may be ready to move towards the kinds of self-sustainable, non-military activities featured in former Soviet programs. In 2004, much of the cooperative threat reduction work with former missile scientists and R&D institutes in Ukraine was oriented toward building their internal capacity to attract contract R&D with commercial technology customers. There was a focus on building familiarity and expertise in commercializing S&T results, in improving the physical resources for producing competitive R&D products, in operating in open business environments, in promoting R&D capabilities to external customers and in securing and protecting intellectual property created by the ex-military scientists and institutes.

In these cases, one possible cooperative initiative would be to establish a "partnership promotion" program, modeled on the Partners Program and capacity-building supplemental activities of the International Science Centers in Moscow and Kiev. Under the Partnership Promotion Program in Ukraine, a variety of activities—basic management training, technology transfer training, strategic growth planning, R&D capacity promotion, travel support to commercial trade shows and technical exhibitions—has been used to connect Ukrainian ex-missile scientists and institutes with governmental and non-governmental programs interested in contracted R&D work. STCU's diplomatic and legal status, plus on-site professional staff, also helps in attracting commercial companies to contract missile scientific teams for R&D work (with the financing and project administration handled by STCU).

The benefits of the Science Center-type of partnership promotion program go beyond the financial leveraging and risk mitigating diplomatic/legal privileges. In Ukraine, the STCU partnership promotion efforts have helped ease the hesitancy of ex-missile scientists/facilities to interact with outside experts and commercial businesses, while also helping them become more comfortable with the complexities of contracted work (with its focus on timetables and expectations on deliverables). Thus, working under the guidance, assistance and oversight of the STCU, the ex-missile scientists have been gradually indoctrinated into this wider science and technology world and have become more confident in dealing with a variety of outside contacts, technical discussions and contractual negotiations and obligations.

Whether or not a "science center" is established in North Korea, a partnership program concept (if adopted) would need a framework agreed to by the DPRK and other participating parties that would allow such commercial or non-governmental partnerships to be established. Under that framework, partnership promotion could be specifically targeted at ex-DPRK missile personnel and facilities wherever such R&D partnerships were feasible and potentially sustainable. Activities coordinated by DPRK and external assistance experts would help to prepare the ex-DPRK missile facilities and personnel for conducting contracted R&D work. Under the oversight of the framework, selected R&D partnerships could be facilitated between the DPRK resources and the interested R&D customers.

Other Phase 3 programs could assist ex-missile personnel and facilities in integrating into larger space cooperation programs. Building on the progress made in the space cooperation track, cooperative missile reduction activities similar to the partnership promotion initiative could be designed to help facilitate (and oversee) the DPRK entry into more substantial space cooperation projects. From the Ukrainian example, conferences, seminars, and small research projects were sponsored by the International Science Center and other programs helped Ukraine in developing indigenous technology and S&T ideas for use in cooperation with other space research programs. Some of the STCU collaborative research projects in aerospace featured, for example, a Ukrainian-US collaborative project that produced an inexpensive nano-satellite equipped for measuring electromagnetic fields near the International Space Station.

Even with growing cooperation, a small portion of the DPRK missile complex might prove "unreachable." In the case of Ukraine—a country that voluntarily gave up its inherited Soviet ballistic missiles and other WMD—some of its missile complex continues to serve legitimate national defense needs, while providing some maintenance services to Ukrainian-produced ballistic missiles still operational in the Russian Federation. Even under optimistic scenarios, Phase 3 agreements could leave in place the DPRK's sovereign right to produce some classes of short-range ballistic missiles for national defense. If this proves to be the case, then the parties may have to accept that a small portion of the DPRK ballistic missile complex will remain dedicated to military production or to the maintenance of deployed missiles. One can assume that this remaining capability will stay off-limits to cooperative reduction activities.

However, even if some continued DPRK missile activity were accepted, it might still be subject to agreed restrictions that would require monitoring by outside parties such as the US (in the same vein that accepted, deployed military forces are subject to monitoring and confidence measures under the START and CFE treaties). To the extent that verification and monitoring measures are applied to such remaining DPRK missile forces, the previous phases' cooperative missile reduction initiatives on verification, monitoring and confidence-building measures could continue to be usefully applied here, and play an important role in enhancing political confidence that the DPRK commitments on restricted ballistic missile production and deployment are being followed.

One challenge is the possibility that much (if not all) of the DPRK missile production facilities are located underground—a substantial arms control monitoring and verification challenge. Open declarations and mutually agreed portal monitoring (*a la* the Votkinsk missile production facility in Russia) may be necessary to create the needed confidence in a DPRK missile reduction/elimination scenario. To that end, it might be possible to design advance cooperative planning approaches and joint trials of monitoring/verification concepts under the Phase 2 and Phase 3 cooperative missile reduction track. These joint cooperative studies and demonstrations would help build confidence in whatever measures are ultimately taken in the missile reduction/elimination portion of this phase.

# CONCLUSION

While the long-term objective of any missile negotiating strategy will be the elimination of threats to the United States and its allies in Northeast Asia, any realistic approach should recognize that objective will only be achieved through agreements that move down the road of elimination in phases. This paper has attempted to lay out in detail a menu of policy-relevant recommendations in the framework of a three-phase arrangement that initially seeks to deal with the most pressing security challenges that, if left unconstrained, could pose a serious threat in the future—long-range and other missiles able to strike the United States and regional targets in other countries. Over the long-term, it seeks to put in place a series of increasing constraints on North Korea.

In that sense, a strategy to eliminate the most dangerous components of the North Korea's missile program is very much like any realistic approach to eventually eliminate its nuclear program. Initially, it may be possible to reach agreements that constrain those efforts, an outcome that would still serve Washington's national security interests given the potential dangers of an unconstrained North Korean effort, but eventual elimination will depend on a shift in overall political, security and economic relations between North Korea and the United States, as well as other countries in the region. Such a shift will have to be embedded in the range of agreements reached throughout the overall engagement process.

In the case of ballistic missiles, the need for an overall shift in the political environment is one obvious and important conclusion that stands out in any analysis of a negotiating strategy. Leaving the political environment aside, this paper has attempted to formulate a strategy that would provide for a durable, irreversible and long-lasting solution to the dangers posed by Pyongyang's program. Given past experience, such a solution will almost certainly need to include arms control limits combined with threat reduction measures and peaceful space cooperation. The latter two types of measures are particularly important if Washington is to ensure for its own peace of mind (as well as of its allies) that North Korea will not suddenly resurrect a missile threat. For Pyongyang, they are important in that both will give the DPRK a stronger stake in any agreements, making it less likely to reverse course. Yet, including these measures and ensuring their implementation will require frequent and close contacts, will require cooperation that, at least today, is not present in the overall political relationship.

Nevertheless, in order to prevent Pyongyang from becoming a small nuclear power with gradually expanding regional and intercontinental reach, Washington should pursue a strategy of negotiations based on realistic expectations. In the near-term, securing important constraints on the DPRK's long-range missile program may still be possible, despite advances made over the past decade—namely developing a long-range capability, which still remains only a distant possibility. Because of that reality, the DPRK may be open to shifting course if Washington pursues an aggressive negotiating strategy designed to avert this danger. Moreover, as this paper has demonstrated, the steps required to secure such an outcome will not be as extensive—or intrusive—as those necessary to move further down the road towards elimination of shorter-range but still dangerous missiles.

US·KOREA
INSTITUTE AT SAIS

US-Korea Institute at SAIS
Johns Hopkins University
1717 Massachusetts Avenue NW, 6th Floor
Washington, DC 20036

www.uskoreainsitute.org