For decades, both North Korea and the United States have in their own way thwarted efforts to resolve the threat of a nuclearized North Korea. Both have cheated on, or failed to fulfill, past agreements to bring a halt to Pyongyang’s nuclear program.

Under Kim Jong Un, North Korea has achieved a level of nuclear and missile development that has finally caught the eye of Washington and the American public. Is peace still possible?

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North Korea’s Missile Progress: Spectacular Success — with No Easy Explanation for It

By Markus Schiller

North Korea’s march toward an operational intercontinental ballistic missile has been dizzying, particularly in recent years. It has unveiled new developments at a rate few nations have matched. And yet the reclusive state would seem to be backward and lacking the sophistication we would associate with such technology.

How have they managed these feats of missile development? Markus Schiller asks if the answer is to be found in the reverse-engineering of Scud missiles decades ago — or has North Korea had significant and ongoing outside assistance?

ON THE MORNING of its Independence Day on July 4 this year, the United States was greeted with a special present: North Korea had just launched a rocket that met every defined specification of a road-mobile intercontinental ballistic missile (ICBM). Seemingly out of the blue, the reclusive state passed a threshold that very few nations have managed before. Just six months earlier, US President Donald Trump had tweeted of this level of threat that “it won’t happen.” But it has.

Some analysts had warned of this for years, and North Korea led up to the launch with a long series of publicity events that were communicated as serious milestones of ICBM development. Two different types of ICBM mock-ups were paraded through Pyongyang in 2012 and 2015; a long-range nuclear warhead design was presented in March 2016; and a week later, a spectacular “heat-shield test” had a warhead tip being burned by a rocket engine. There were also static rocket-motor tests in April 2016, September 2016 and March 2017 of large engines and engine clusters that seemed powerful enough to propel an ICBM.

On top of that, North Korea was presenting one new missile after another at an ever-increasing pace. While only five different guided ballistic-missile types (plus two different space launchers) were known to have lifted off in North Korea before Kim Jong Un took over, the total range of functional ballistic missiles and large rockets rose to 15 with the Hwasong-14 ICBM launch in July this year; an additional five missiles that have not left the ground yet were hinted at in parades or other occasions (see table on page 18).

This pace is nearly unheard of. To give an example, Russia’s most recent submarine-launched ballistic missile (SLBM), the Bulava, took almost 20 years to develop, and failed again and again, while North Korea’s very first SLBM, the KN-11 or Pukguksong-1, was apparently developed in a tenth of that time (some experts even claim that North Korea initially developed a liquid-fueled version, and switched to solid fuel after the first tests, within less than a year — something that has never been done anywhere before). Granted, the Bulava is a lot bigger, more complex and powerful than the KN-11, but Russia already had decades of experience with solid-fueled missiles, while North Korea basically started from scratch.

HOW DOES IT DO THIS?

This should raise questions about how North Korea could achieve these feats. However, many experts just shrug that off, stating that Kim just decided to focus all his resources on missiles. This may be true. But can a state under almost total international sanctions with little known high-tech industry really pull off something like this? If yes, why did North Korea choose ballistic missiles as its showcase? Why not aircraft, or surface-to-air missiles? Why not push an indigenous automotive industry and earn some hard currency abroad instead of getting additional sanctions for every missile launched? Is it really the fear of forced regime change initiated by the US and its allies that drives the missile program to unprecedented achievements? Other countries, from the US to Russia, China, France or India, required many more years and resources for comparable achievements.

These questions can be answered two ways: One is quick and easy, the other requires a very comprehensive look at various parts of a huge puzzle. Let’s try both.

THE QUICK AND EASY ANSWER

This is best done by referring to what could be called “public knowledge” about North Korea. And the easiest place to look is Wikipedia, which is a democratic instrument of agreement on issues of public interest due to its open editing structure. The various articles about North Korea’s missiles all paint a picture that can be summarized as this: North Korea obtained Soviet Scud missiles from Egypt sometime in the 1980s and quickly reverse-engineered these to build indigenous copies, building more advanced versions of these missiles over the years. Having mastered Scud technology, North Korea switched to more capable technologies that are also mostly based on other old Soviet designs. Next was the so-called SS-N-6 technology, and, most recently, the engines that were observed in the Hwasong-14 ICBM (even though they have been referenced simply as “Ukrainian” in many news outlets, the whole family of engines was developed in Soviet times at an institute in Moscow). As proof for this narrative, it is common to hint at papers that tell the same story, referencing back to other papers that tell the same story, until the trace is lost, or ends at some “secret government source.”

THE TOUGH ANSWER

The other approach is painful and challenges the “known truths.” It is based on rules that apply everywhere else in the world, and for every other technological field, and it requires accepting Murphy’s Law, the old saw that states that where something can go wrong, it will go wrong. You know how this goes: The new IKEA wardrobe usually is harder to assemble than expected and in the end, one or two screws are missing. The new piece of software that “quickly” reorganizes all your favorite photos and music will do a lot of things, but not organize your files in the way you intended. The picture you just wanted to

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The test launch on Aug. 29 this year of a Hwasong-12 long-range missile.

Photo courtesy of KCNA
hang on the wall is now lying on the floor, broken, while you stare at the hole where the nail should have been. Things just go wrong because plans never play out as originally intended. This has two very important consequences:

- **Things must be tested, again and again and again.**
- **If something doesn't work, it has to be changed.**

In terms of a rocket system, this not only applies to its complete form, but filters down to every single component, element and part of a rocket. Indeed, virtually every known attempt at reverse-engineering leads to a similar product, but never to an identical product. This is because the details of a complex piece of hardware get changed along the way not only because they did not work the intended way, but also for other possible reasons. Maybe the original materials are not available and have to be substituted, requiring a redesign of the part; perhaps misunderstood design solutions are “improved” on the go, leading to different details being changed. It could be that the manufacturing process is unknown, so a different approach is selected — in chemical engineering, this can be compared to trying to cook a meal by only seeing the finished food on the plate. As a result, simple parts of the original hardware that apparently do not serve any special purpose may be substituted with different parts, materials or looks.

Therefore, a reverse-engineered Swiss watch will be different from the original just as a reverse-engineered rocket engine or missile will be different — and the higher the number of parts and elements, the more the differences will be visible.

What does this have to do with North Korea?

The thing is: North Korea did not really test its missiles back in the 1980s and 1990s. Nonetheless, it seems they worked very well. And the Scuds looked exactly like the Soviet originals — they even sported Cyrillic letters. Oh, and they came with all the required support systems for a Scud B, a weapons system that included more than a dozen specialized vehicles, and the vehicles seen so far in North Korea look exactly like the Soviet originals, too. Did they quickly reverse-engineer these, too? Didn’t they receive just three missiles from Egypt, without any support equipment? The fact is that North Korea exported at least 100 (some sources say more) of these Scud clones to Iran in the late 1980s, where they were fired against Iraq with a very low failure rate.

It might have been a coincidence, but at that time, the Soviets were just phasing out the Scud B system. Today, no one knows what became of these systems, comprised of hundreds of missiles and support vehicles.

It therefore seems likely that North Korea did not quickly reverse-engineer its first ballistic missile, the Scud B, but simply received the system from the Soviets. But this was three decades ago, why is this relevant now?

This can only be explained by following North Korea’s missile program step by step.

### BUILDING THE CASE THAT PYONGYANG HAD OUTSIDE HELP

If North Korea did not reverse-engineer the Scud B in the late 1980s, it therefore did not have any experience in building missiles in the early 1990s. So, it should have been hard for it to design and produce the Scud C, a more advanced Scud version that appeared in 1990. But it was not. Only two launches of the Scud C are known in North Korea, in 1990 and 1991, and both were successful. This is not what you would expect from the very first indigenous missile development in any country. The same happened with the next missile, the Nodong, which looks like an enlarged Scud. It flew once in 1993 (successfully), and from 1998 on, the missile system was transferred to Pakistan and Iran in noteworthy numbers. Interestingly enough, there are also Soviet counterparts of both the Scud C and the Nodong.

To drive home the point, we briefly have to delve into engineering details to point out another mystery: The Scud C featured many smart design solutions that increased its range compared to its predecessor, from 300 kilometers to 500 kilometers. But not a single one of these design solutions was incorporated into the Nodong missile, not even at later stages — while Iran slowly evolved the Nodong design into something far more capable (the Ghadr missile), North Korea still sticks to the original version. Why design the Nodong as a large Scud B, and not as a large Scud C?

The story goes on. In 1998, a large space launcher, the Taepodong I, appeared, and in its first and only flight it almost succeeded in putting a satellite into orbit. Remember, this was done by the same people who had gained no experience through Scud B, Scud C or Nodong development. There must have been massive help from outside to explain that success.

However, North Korea apparently scrapped the promising Taepodong I design and went for a very different, and much bigger, rocket, what was later known as the Taepodong II, or the Unha space launcher. The first rumors of this go back to the early 1990s, and a mock-up was observed in 1994. However, the first launch only occurred in 2006 (a failure), and later in 2009 and April 2012 (both failures). Only in December 2012 did the rocket successfully complete its first mission, about 20 years into development. This time, the pace and failure record made sense — orbital launch success at fourth launch after two decades is still an impressive feat. South Korea recovered the first stage of this rocket from the ocean, and what they found does not fit well into the “indigenous reverse-engineering” theory. The United Nations identified many parts as being imported from abroad, and the ball bearings inside the engines (which were clustered
The KN-11 SLBM came out of nowhere, and the “improved” KN-02 looks exactly like the old with Chinese/Pakistani solid rocket motors. Overdid it. All the “new” rockets flown since then out of nine test launches failed. It also boasts unrealistic performance claims. The Hwasong-12 uses a completely different engine than any previous North Korean rocket. The engine looks like it is from the Soviet/Ukrainian RD-250 family. The KN-18 is just a Scud C with a different warhead and unrealistic accuracy claims. The Hwasong-14 uses the same Soviet/Ukrainian design engine as the Hwasong-12. Even though North Korea now launches rockets frequently, including some failures, the track record of success is still unusually high. Especially considering that there had been no prior experience from Scud reverse-engineering, so they actually had to start from zero. There also remains the question of why North Korea seems to start over again and again, using completely new (but nonetheless familiar) technology for its various missiles — almost as if they get access to new proliferation sources time and again. All this can only be explained by some sort of external help, combined with the insight that the North Korean program still is not exactly what they want the world to believe it is. This, however, also means that there might be more surprises coming.

THE TWO EXPLANATIONS — YOU DECIDE
So there are at least two ways to explain North Korea’s missile program. The quick and simple “reverse-engineering” explanation is favored not only by Wikipedia, but also by a broad community of experts and institutions that focus their technical questions about both missiles (meaning rocket technologies) and weapons of mass destruction (meaning chemical, biological, and nuclear weapons), while being rooted in political science.

The other way around rarely happens: There is not a single department of engineering that has an audible voice in the North Korean threat assessment community. Perhaps people that actually build rockets are not interested in political assessments, or they are not allowed to join public conversations for security reasons (which is certainly true for people building nuclear weapons). However, in the few times that real rocket people — meaning those with hands-on rocket program experience — are asked about their thoughts on North Korean successes, they answer with statements that could be summarized as this: “They easily succeed where we keep failing. Our rockets always explode.” This sounds a lot like they would tend toward the second way of explaining the North Korean rocket mystery.

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