

North Korea ups pace of ballistic missile launches

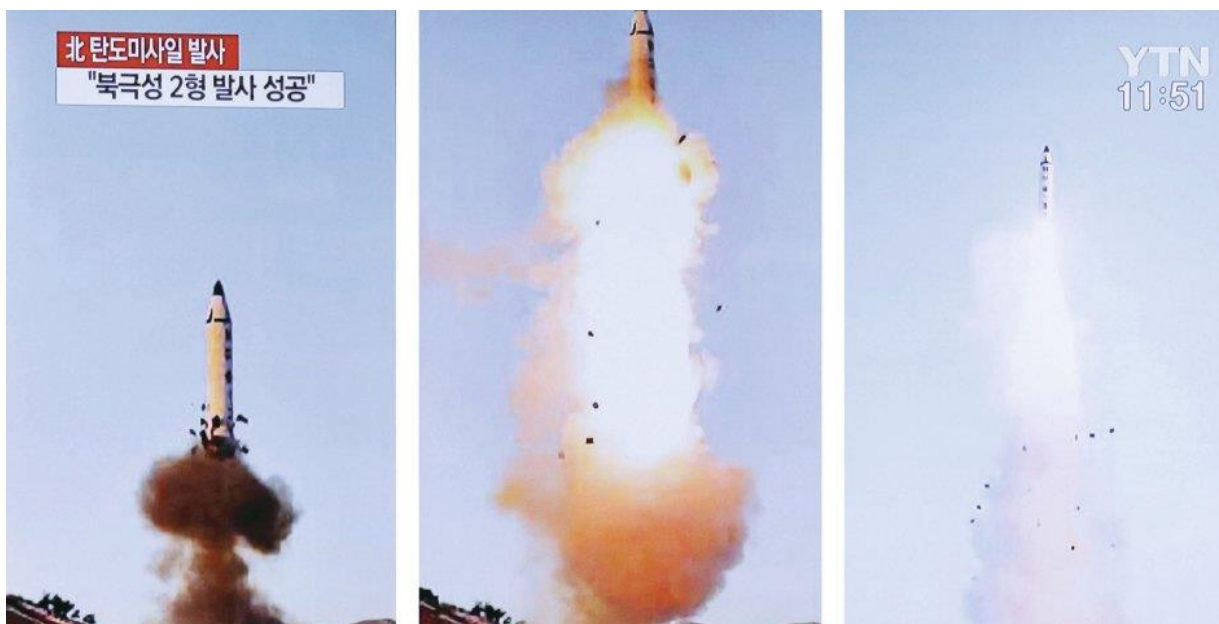
[Content preview – Subscribe to IHS Jane's Intelligence Review for full article]

North Korea has conducted more ballistic missile launches since 2011 than it did in the previous two decades under Kim Jong-il. *Nick Hansen* surveys the country's ballistic missile programme and analyses the possible motivations for its acceleration.

North Korea's launch of four ballistic missiles on 6 March again underlined the ongoing rapid pace of its missile launches. Footage released by North Korea enabled the identification of the missiles as Scud D/ER short-range ballistic missiles (SRBMs). They were launched at approximately 0736 local time from an area near the Tongchang-ri Missile and Space Launch Facility on the west coast of the country - the first time that it has been used as a launch site for an operational missile. Three of the four missiles landed in Japan's exclusive economic zone, prompting diplomatic protests from Tokyo.

Since Kim Jong-un came to power in December 2011, North Korea has attempted to launch nearly three times as many ballistic missiles as during the entire reign of his father, Kim Jong-il. Between 2011 and the end of 2016, North Korea launched a total of 42 ballistic missiles: 20 short-range Scud-type missiles with a range of 300-1,000 km, 10 medium-range No Dong missiles that can fly 1,300-1,500 km, eight intermediate-range Hwasong 10 (Musudan) missiles traditionally assessed to have a range of 3,500-4,000 km, and four submarine-launched ballistic missiles (SLBMs).

These tests can be divided into three categories: tests of operational missiles, tests of missiles North Korea considered operational but were untested (such as the Musudan), and those still under development (such as the Pukkuksong [Polaris] family of solid-fuelled missiles).



A still of a TV news programme showing photos published in North Korea's Rodong Sinmun newspaper of the country's Pukkuksong-2 missile launch on 12 February 2017. (Reuters/KCNA)

1696938

Testing established missile systems enables greater confidence in their capabilities and acts as an effective diplomatic signalling device. However, the motivation behind testing the previously untested Musudan missiles is harder to determine. One possibility is that Pyongyang required proof that the missiles that had been developed work as claimed - this would suggest a degree of distrust between the leadership and those responsible for designing North Korea's missiles. Alternatively, the increased rate of testing may suggest the emergence of a more permissive atmosphere in which North Korean engineers are now able to tolerate failure.

Internal and external prestige may be another reason; Kim has boasted domestically and through the international media that these missiles could hit his Asian enemies, US forces in Asia, and soon the US mainland. These boasts were premature, as the missile tests have generally not lived up to his expectations. However, where there have been successes, these have been used in propaganda videos released to prove to his people and to the world that his missiles were ready for combat.

[Continued in full version...]

Established systems

Throughout the course of 2016, North Korea launched 12 short- and medium-range ballistic missiles including Hwasong 6 (Scud C), Hwasong 7 (Scud D/Extended Range [ER]), and No Dong missile systems. Despite initial reporting suggesting several launch locations, the majority of these appear to have been launched from the Pyongyang to Kaesong highway, 5.5 km west of Hwanqiu city on the west coast (38° 39' 40.8" N, 125° 42' 29.8" E).

North Korean Scud-type launches (2016)					
Date	Time	Missile	Notes	Analysis	
10 March 2016	0520	Scud C	Successful launch: flew 500 km	Scud C Scud D/ER SRBM success rate 100%	
	0520		Successful launch: flew 500 km		
18 March 2016	0555	No Dong	Successful launch: flew 800 km		
	0615		Failed shortly after lift-off		
19 July 2016	0545	Scud C	Successful launch		
	c.0600	No Dong	Failed at 30 km altitude		
	0640		Successful launch		
3 August 2016	0750	No Dong	Launch failure: missile exploded at launch		No Dong MRBM success rate 50%
	0750		Successful launch: flew ~1,000 km		
5 September 2016	1213	Scud D/ER	Initially identified as No Dong missile Successful launches: flew ~1,000 km		
	1214				
	1214				

Note: The information in this table is based on reports in open-source and satellite imagery analysis. Dates, times, and launch locations are best estimates based on the available data. All launches are assessed to have taken place from the Pyongyang-Kaesong highway. Red colour indicates a failed launch.

Source: IHS Jane's © 2017 IHS Markit: 1696552

North Korean Scud-type launches (2016) (IHS Jane's)

1696552

Although these are considered established missile systems, a number of lessons will have been learned from these launches. The short-range Scud-based missiles achieved six successes out of six launches, including three of the Scud D/ER missiles that flew to an impact area 1,000 km away.

[Continued in full version...]

Musudan revisited

The Musudan intermediate range ballistic missile (IRBM) was observed for the first time in 2003 satellite imagery of Mirim Airfield near Pyongyang. These images were never revealed, and their existence is understood only from reports in the South Korean media and subsequent academic works. Eight missiles were first displayed in a 2010 military parade in Pyongyang. Unlike the Scud-based missiles, the Musudan may be based on SS-N-6 'Serb'/R-27 'Zyb' technology, which uses higher-energy propellant, although there are differing assessments on this matter.

In March 2010, the South Korean JoongAng Daily cited an unnamed South Korean government source as claiming that North Korea had established a new "military division responsible for operating intermediate range ballistic missiles". Coupled with the parade photos, this report indicates that the Musudan may be operationally deployed. Despite this, the first flight test series only began between April and October 2016. During this period, up to eight Musudan missiles were launched across three locations. The first was launched from the Hodo Peninsula, northeast of the city of Wonsan, on 14 April 2016, probably from a small military testing facility at 39° 24' 28.6" N, 127° 31' 58.8 E. According to South Korean media reports, it failed in flight after launch.

A second and third Musudan were launched on 28 April, also from the Hodo Peninsula. Both missiles failed and it is notable that with just 12 hours' separation between launches, the North Korean operators would have had little to no time to determine the cause of the first failure before the second launch. This suggests that they were conducted in a desperate attempt to achieve a success.



Two stills from video footage released by North Korea of the four missiles launched from an area near the Tongchang-ri Missile and Space Launch Facility at around 0734 local time on 6 March. (IHS Markit/KCNA)

1686234

The next Musudan test series took place on Kalama Beach to the east of Wonsan. The first of the launches on 31 May also failed as the missile may have exploded on the transporter erector launcher (TEL). Two further tests (launches five and six) took place on 22 June. Although the first missile flew approximately 150 km before it was reported by South Korean officials to have disintegrated in flight, on 6 July the North Korean state-run Uriminzokkiri website announced that the initial launch had been a success, as the missile had been intentionally destroyed in flight by an on-board explosive device.

The second missile was much more successful; it flew a lofted trajectory to an altitude of over 1,000 km and impacted in the Sea of Japan 400 km downrange. North Korea declared this launch a success, released video of the event, and celebrated with the launch troops. It is not known if the launch was a complete success, and by the appearance of the pad in satellite imagery it appears that the TEL was heavily damaged or destroyed by a fire after the launch. Nevertheless, it was by far the most successful of the six Musudan launches.

[Continued in full version...]

North Korean Musudan launches (2016)				
Date	Time	Launch location	Comment	Analysis
14 April 2016	0530	Hodo Peninsula	Failed in flight after launch	Musudan IRBM success rate 12.5%
28 April 2016	0610		Failed on the TEL	
	0856		Failed in flight, 200 m from the TEL	
31 May 2016	0520	Kalama Beach	Failed on the TEL	
22 June 2016	0558		Flew about 150 km before reportedly disintegrating in flight	
	0805		Successful launch: flew a lofted trajectory to an altitude of more than 1,000 km, impacting the Sea of Japan 400 km downrange	
15 October 2016	1203	Panghyon airfield	Failed shortly after launch	
19 October 2016	0630		Failed in flight	

Note: The information in this table is based on reports in open-source and satellite imagery analysis. Dates, times, and launch locations are best estimates based on the available data. Red colour indicates a failed launch.

Source: IHS Jane's © 2017 IHS Markit: 1696553

North Korean Musudan launches (2016) (IHS Jane's)

1696553

Pukkuksong family

In addition to its liquid-fuelled programmes, North Korea has also embarked on a solid-fuelled missile programme and, to date, has produced two members of the Pukkuksong family.

The first North Korean solid-fuelled missile seen was the Pukkuksong-1 SLBM, identified as the KN-11 by the United States. The missile is a two-stage solid-fuel rocket and is probably classified as a medium-range ballistic missile (MRBM). The missile programme has gone through major test phases and has included 12 known events since October 2014, involving the use of a land pop-up test stand, a submergible barge, and the Gorae-class test submarine. New technologies have also emerged from the programme including large solid-fuel motors, cold gas generators, and launch tubes for underwater launch.

Incremental progress in the programme, including several partial successes, has been observed, including on 23 April 2016, with Kim in attendance, of the second launch of a Pukkuksong-1 missile from the Gorae-class submarine.

Notwithstanding North Korean propaganda claims, the first and only definitively successful launch of the missile occurred on 23 August 2016 with Kim directing the launch. The Gorae-class submarine was submerged in the harbour off the Sinpo Naval Base and launched in near darkness at 0550 local time. The missile flew a lofted trajectory to a range of 500 km, achieved an altitude of 550 km, and impacted in the South China Sea.

As with successes in other missile and space tests, extensive video footage was released of Kim directing the launch preparations, the launch itself, and the celebration when the submarine returned to port. A December 2016 report by South Korean think-tank the Institute for Korean Studies claimed that the missile would be capable of a range of 600 km with a 1,000 kg warhead if flown on a normal trajectory - longer ranges would be possible with a lighter warhead - and the report noted that "longer ranges cannot be ruled out". Additional missile tests are likely in 2017.

[Continued in full version...]

Selected timeline of North Korean SLBM development		
Date	Launch location	Comment
October and November 2014	Onshore testing facility	Ejection tests at a new onshore facility at Sinpo.
December 2014 and January 2015	Barge (surfaced)	Further ejection tests moved to a barge with a launch tube anchored on the surface.
22 April 2015	Barge (submerged)	Test from submerged barge. Reported failure.
9 May 2015	Barge (submerged)	Test from submerged barge. Engine ignited for a short burn. Reported failure although subsequent video release suggests at least partial success.
28 November 2015	Gorae-class submarine	Gorae class used for a submerged test. The test was reported to have damaged the sub, considered a failure.
21 December 2015	Barge (submerged)	Return to barge supports reports of submarine damaged. Reported failure: The missile appears to have failed after the motor ignited.
16 March 2016	Onshore testing facility	Testing returned to the onshore test site for another ejection test. Possibly to test a cold launch ejection system.
23 April 2016	Gorae-class submarine	With Kim in attendance, the second launch from the Gorae-class submarine occurred. Partial success: The missile only flew 30 km but was declared a success by North Korea and video footage released.
9 July 2016	Gorae-class submarine	SLBM from the test submarine. It reportedly failed early in flight.
23 August 2016	Gorae-class submarine	The first successful launch of the missile occurred with Kim directing the launch.
15 December 2016	Onshore testing facility	Ejection test, possibly for the Pukkuksong-2 ground-launched missile.

Source: IHS Jane's © 2017 IHS Markit: 1696554

Selected timeline of North Korean SLBM development (IHS Jane's)

1696554

Mobile land-launched missile

In addition to its submarine-launched relative, North Korea has developed a land-based road-mobile solid-fuelled MRBM - the Pukkuksong-2 - which it first launched on 12 February 2017 at 0752 local time (late 11 February in the US). Two days later, North Korea released pre-launch, launch, and post-launch video of the new missile system. Analysis of the footage suggests that the missile was similar to the two-stage Pukkuksong SLBM with a different warhead, which was positioned inside a launch tube and carried on a large tracked vehicle. These features are unlike any other North Korean mobile missile transporter observed to date.

IHS Jane's identified the launch site on a new tracked vehicle training area at 40° 0' 42.39" N, 125° 13' 9.8472" E. The missile travelled a high-angle trajectory for 500 km, achieved an altitude

of 550 km, and impacted in the East Sea. Kim directed the launch and after the successful mission he held his customary celebration with the troops.



A screen at the General Satellite Control and Command Center in Pyongyang shows North Korea's Unha-3 rocket launching on 12 December 2012. North Korea successfully fired the rocket, defying international warnings. (PA)

1482774

Technically, the Pukkuksong-2 is a close relative to the Pukkuksong-1 SLBM, which may be appealing for North Korea as having two similar missiles will reduce costs. As a solid-fuelled missile it is easier to store and prepare for launch. The land-based missile probably has a range of approximately 1,200 km. This makes it an MRBM and not an intercontinental ballistic missile (ICBM). As a weapon, it is similar in range to the older Scud Cs, Scud D/ERs, and older No Dong missiles and may be intended to be a replacement for those missiles as they age.

The tracked TEL that it is mounted on is a throwback to the 1960s Soviet missile systems, SS-14 and SS-X-15, that were either deployed in small numbers or never deployed. In part this is because the system was extremely difficult to maintain. The weight of the solid-fuelled missile and the launch tube may be too heavy for the current Scud and No Dong TELs. It is likely that a wheeled TEL for the missile will be developed in the future or that North Korea will modify the Musudan TEL, a demilitarised vehicle that carried the solid fuel Soviet SS-20 IRBM. The launch tube that the missile is mounted in provides environmental control for the solid missile and may be similar to the one on the submarine.

[Continued in full version...]

Outlook

For North Korea's missile programme, the biggest successes achieved in 2016/17 were in its long-range, solid-fuelled missile programmes. This represents a major change in direction from more than three decades of liquid-fuelled rockets. Given North Korea's demonstrated capability to mix

and pour large solid-fuel rocket motors, not only could it replace shorter-range systems, but longer-range solid-fuel missiles may also be introduced.

The biggest disappointment was the Musudan IRBM, with a success rate of only 12.5%. The test failures of this system probably highlighted the value of conducting a flight test programme before operationalising a missile system. Accordingly, one likely avenue for the expansion of North Korea's solid-fuel missile programme would be to produce solid-fuel motors for a Musudan replacement.

The pace of tests has enabled North Korea's propaganda machine to produce videos at a more rapid rate than ever before. More broadly, the developments of 2016 and early 2017 consolidate previous trends wherein North Korea has emphasised the survivability of its missile systems. Mobile missile systems are able to geographically disperse and are inherently survivable. North Korea may seek to increase its operational readiness by replacing its Scud-based inventory with newer missiles or it may seek to complicate foreign strike options by increasing the number of systems to be targeted.

[Continued in full version...]

For the full version and more content:

IHS Jane's Military & Security Assessments Intelligence Centre

This analysis is taken from [IHS Jane's Military & Security Assessments Intelligence Centre](#), which delivers comprehensive and reliable country risk and military capabilities information, analysis and daily insight.

IHS country risk and military capabilities news and analysis is also available within IHS Jane's Intelligence Review. To learn more and to subscribe to IHS Jane's Intelligence Review online, offline or print visit <http://magazines.ihs.com/>

For advertising solutions contact the [IHS Jane's Advertising team](#)