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# BRIEF ON THE DEFENCE DEVELOPMENT EXHIBITION OF THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

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# **BRIEF ON THE DEFENCE DEVELOPMENT EXHIBITION OF THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA**

Tianran XU

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On 11 October 2021, the Democratic People's Republic of Korea (DPRK) held a defence development exhibition entitled "Self-Defence-2021" in Pyongyang to celebrate the 76th anniversary of the founding of the Workers' Party of Korea (WPK). In the exhibition, a wide variety of weapons was displayed, ranging from light arms to intercontinental ballistic missiles (ICBMs). On 12 October, the Korean Central News Agency and the WPK newspaper Rodong Sinmun released photos of the exhibition. In addition to many weapons that had previously been publicly displayed by the DPRK, these photos also revealed three new ballistic missiles. Also on 12 October, Korean Central Television aired a 34 minute report on the exhibition. The video footage showed more previously unseen weapon systems of the DPRK. The exhibition offered a rare glimpse into the depth and ingenuity of the DPRK's arms build-up.

This report offers a preliminary analysis of the new weapon systems and newly revealed information about some of the previously known weapon systems of the DPRK.

## SUMMARY OF FINDINGS

The exhibition shows that:

1. Despite its difficult economic situation, the DPRK has continued to invest considerable resources in developing new military technologies;
2. The DPRK has been able to procure or locally manufacture key components for advanced weapon systems that are difficult to import due to international sanctions;
3. The DPRK's efforts in both nuclear and conventional military development are extensive in depth and scope; and
4. Although some weapons showcased at the exhibition may not yet be completed, their development should be closely monitored.

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## I. BALLISTIC MISSILES

The following section includes information about three ballistic missiles that made their public debut at the exhibition and new information revealed at the exhibition about ballistic missiles previously made public by the DPRK.

As shown in Figure 1, three new ballistic missiles were displayed at the exhibition. They

are: (1) a missile with a hypersonic glide vehicle; (2) a missile marked as “Missile B”; and (3) a submarine-launched-ballistic missile marked as “New SLBM.” The three new missiles were displayed along with the Hwasong-12 intermediate-range ballistic missile (IRBM), Pukguksong-1 and Pukguksong-5 SLBMs.



Figure 1. Ballistic missiles showcased at the exhibition.

Image: KCTV

## A. New Hypersonic Ballistic Missile

A new ballistic missile, armed with a hypersonic glide vehicle and carried by a transport erector launcher (TEL) based on the MAZ-547 truck, was displayed at the exhibition. It appears that the TEL of this new hypersonic missile is the same as that of the Hwasong-12 IRBM. (Figure 2).

As shown in Figure 3, the number of steps on the ladder in the erection arm for the Hwasong-12 and the corresponding number of steps for the new hypersonic missile are the same. The sections between the upper end of the rocket stages and the upper end of the erection arms on the Hwasong-12 and the new hypersonic missile also have approximately the same length. These two observations suggest that the Hwasong-12 and the new hypersonic missile are similar in length.

Previously, on 28 September 2021, the DPRK tested a hypersonic missile that was designated as the Hwasong-8.<sup>1</sup> The Hwasong-8 appears to be powered by the same type of engine that powers the Hwasong-12. However, the Hwasong-8 seems to be shorter in length than the Hwasong-12 (Figure 4). As the Hwasong-12 and the new hypersonic missile have similar lengths, it is reasonable to conclude that the new hypersonic missile is longer than the Hwasong-8 tested on 28 September.

It is possible that the Hwasong-8 tested on 28 September is an interim test product, and that a more developed version of this missile was displayed at the exhibition. However, without further information, there is no definitive explanation for the difference in length between the Hwasong-8 and the newly exhibited hypersonic missile.



Figure 2. The new hypersonic missile in the exhibition (two photos on the left; bottom image flipped to facilitate comparison) and the Hwasong-12 IRBM (two photos on the right) are carried by the same type of TEL (in all four photos), although the TEL in the exhibition (two photos on the left) has a modified cabin, among other minor changes.

Images: KCNA, KCTV



Figure 3. The number of steps on the same section of the erection arms for the new hypersonic missile (top) and the Hwasong-12 (bottom right) is the same; The sections between the upper end of the rocket stages and the upper end of the erection arms on the hypersonic missile (top) and the Hwasong-12 (bottom left) are marked in white boxes.

Images: KCNA, KCTV, annotated by ONN

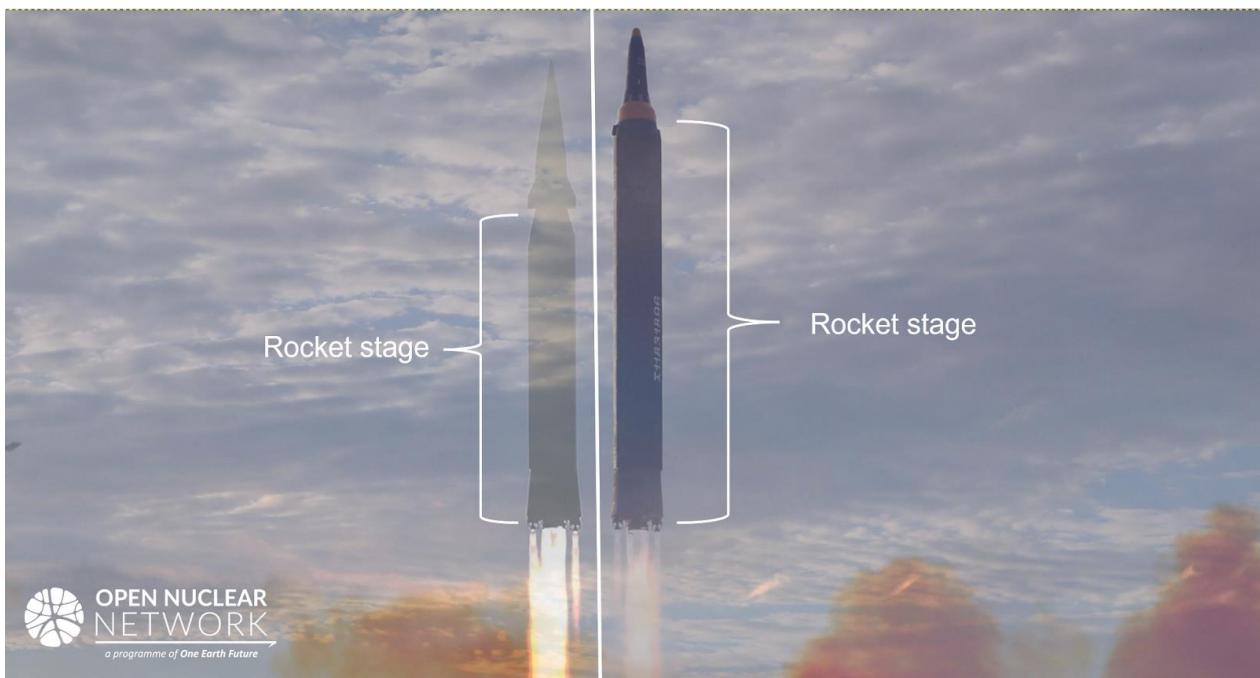


Figure 4. Using the engine section as reference, it appears that the rocket stage of the Hwasong-8 hypersonic missile tested on 28 September (left) is significantly shorter than that of the Hwasong-12 (right, photo taken on 29 August 2017).

Images: KCNA.

## B. Missile B

Another new missile, marked as “Missile B” as shown in Figures 1 and 5, appears to be significantly shorter than the Hwasong-12 (Figure 1) and is also different from the new hypersonic missile referred to above insofar as it has a different warhead (Figure 5).

Missile B might also be a hypersonic weapon, as its relatively large rocket stage and the presumably manoeuvrable warhead indicate that the warhead might be able to travel at Mach 5 or above and to some extent perform manoeuvres.

It is also not entirely clear what engine is used to power “Missile B”.



Figure 5. The warhead of the new hypersonic missile (top left) has a shape similar to that of the Chinese DF-17 (top right). The warhead of “Missile B” (bottom left) is similar to that of a DPRK precision strike variant of the SCUD missile (bottom right). The only known test of this precision strike SCUD variant was carried out on 29 May 2017.<sup>2</sup>

Images: KCNA, KCTV, News.cn

## C. New SLBM

As shown in Figure 1 above, a previously unseen missile, possibly an SLBM, was displayed beside the Pukguksong-1 and Pukguksong-5 SLBMs in the ballistic missile exhibition area. The missile is smaller than the Pukguksong-1 SLBM; It appears to be powered by a single stage solid rocket motor and has four “bumps” around the tail section (Figure 6). Four grid fins, possibly in a folded position before launch, are located between the four bumps. The DPRK has applied grid fins to stabilize the trajectory of the Pukguksong-1 SLBM and the Pukguksong-2 land-based ballistic missile. However, it is uncertain what the exact function of the four

bumps around the tail of the missile is. One hypothesis is that the bumps are made to accommodate the attitude control system (Figure 7). The bumps might also play a role in ejecting the missile from the submarine. There is no available information to assess whether this new SLBM will be deployed by the Navy. It is worth noting that, including this new SLBM, the DPRK has showcased a total of five types of SLBMs since 2016. Among them, only the Pukguksong-1 and Pukguksong-3 are known to have undergone flight tests, with both of those missiles being fully tested only once.<sup>3</sup> As of the date of this report, there have been no updates regarding the DPRK’s ballistic missile submarines since July 2019.<sup>4</sup>

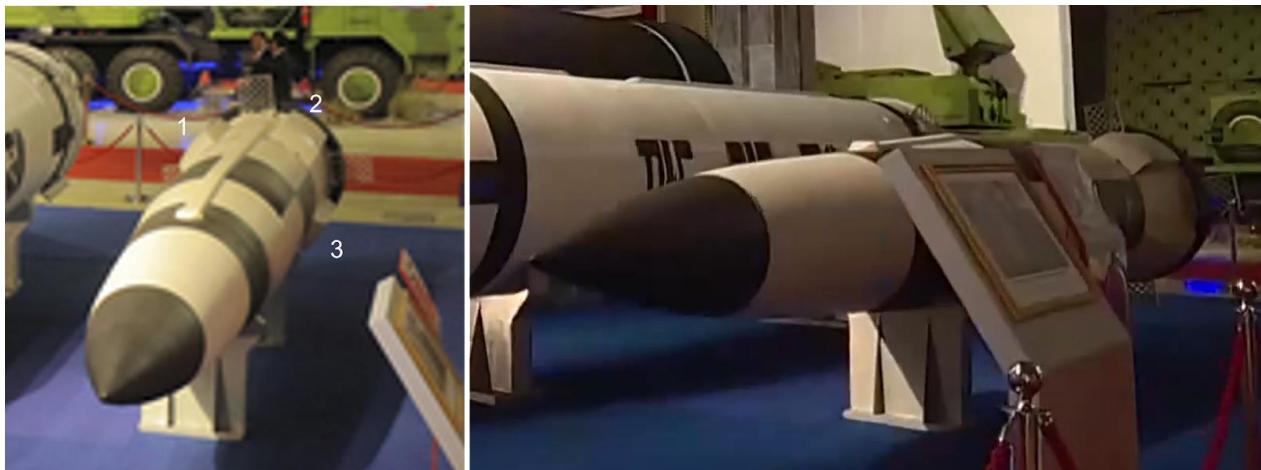


Figure 6. The small SLBM that made its public debut at the exhibition (left and right). The three visible bumps are marked by numbers (left).

Images: KCNA, KCTV



Figure 7. The Iranian Sejil solid fuel ballistic missile has bumps around its rocket nozzle. The bumps accommodate the jet vanes (in white circles), which control the attitude of the missile by directly deflecting the flame of the rocket motor.

Image: Hawzah News Agency

## D. Hwasong-11Na

The display at the exhibition revealed that the official designation of the solid fuel short range ballistic missile, referred to as the KN-24 by the US Government, is "Hwasong-

11Na" (화성포-11나, see Figure 8). The use of "나" [translated as Na] may suggest that it is a second iteration of this model as "나" is the second letter in the Korean alphabet.



Figure 8. The official designation of the KN-24 ballistic missile was revealed at the exhibition.

Image: KCNA

## E. Hwasong-17

The KCTV report on the exhibition showed part of the official name of the large land mobile ICBM that was showcased in the 10 October 2020 parade (see top of the screen in Figure 9 below).<sup>5</sup> It can be read as either

"Hwasong-11" or "Hwasong-17". If, as concluded above, the official designation of the KN-24 is "Hwasong-11Na," it is reasonable to conclude that the official designation of this large ICBM is most likely "Hwasong-17" (Figure 9), which has yet to be flight tested.



Figure 9. The partial name aired by KCNA suggests that the official name of the ICBM first showcased in October 2020 is "Hwasong-17."

Image: KCNA, annotated by ONN

## F. KN-25

The KN-25 is referred to by the DPRK as the “super large caliber” (presumed to be of about 600 mm caliber) multiple rocket launcher (MRL). The KN-25 flies a ballistic trajectory, which can be fine tuned through a guidance system. Because of its resemblance to a ballistic missile, it is also included in this section on ballistic missiles as opposed to the next section featuring other weapons.

The KCTV news report on the exhibition showed that three pairs of bracket-shaped wrap-around fins are installed on a rotating sleeve (Figure 10) around the nozzle of the

KN-25. A rotating sleeve is often used for tactical missiles (especially in air-to-air and surface-to-air missiles) to control flight stability along the rolling axis.<sup>6</sup> Therefore, the KN-25 is likely to be stabilized along its rolling axis by the movement of the rotating sleeve. As the rocket body itself does not have to rotate, the KN-25 could offer a more favourable working environment for the onboard guidance system than traditional MRLs that rely on a rolling body design. The rotating sleeve is uncommon in MRL rounds. The adoption of the rotating sleeve demonstrates a considerable innovation capability of the DPRK.



Figure 10. KCTV footage shows the rolling movement of the KN-29's tail fins on a rotating sleeve.

Image: KCTV

## II. OTHER WEAPONS

This section offers an introduction to other new weapons disclosed for the first time at the exhibition, as well as new information about weapons that have already been publicly acknowledged or showcased by the DPRK.

### A. New Surface-to-Air Missile (SAM)

The new SAM that was tested on 30 September<sup>7</sup> was also showcased in the

exhibition. Judging from the photo released on 12 October, the missile has a total of 12 aerodynamic surfaces (three sets of possibly fixed wings and possibly movable fins) and a booster with four wings. It is not entirely clear what the exact role is of each set of aerodynamic surfaces. Upon closer examination, it appears that the booster of one missile is longer than that of the other (Figure 11). Presumably the two boosters are meant to offer different range options.

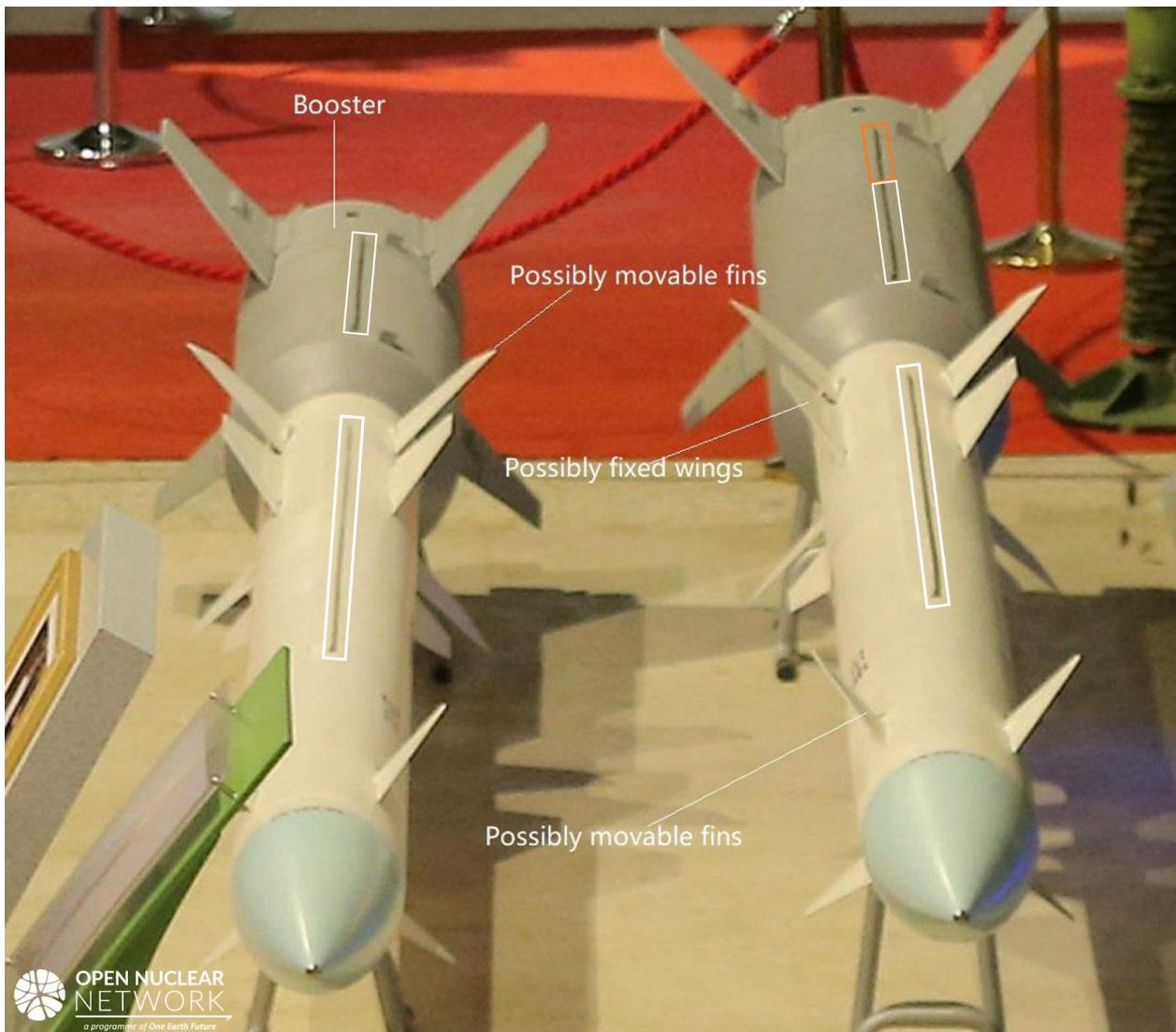


Figure 11. The cable raceways (in white and orange boxes) are indicative of the length of the missiles' solid motors. A comparison shows that the missile on the right has a longer booster than the one on the left (as marked in the orange box).

Image: KCNA, annotated by ONN

## B. Land-Based Radars

Radar systems are a crucial component for the development of an air defence and coastal defence networks. Four new radars were displayed at the exhibition.

### 1. First Radar

A radar, which is partially hidden behind a wall that separates it from the new SAM, can be seen at the exhibition (Figure 12). It is not clear what function this radar may serve. One possibility is that it is a modification based on the fire control radar of the KN-06 SAM.



Figure 12. Partial view of a radar (left). The fire control radar of the KN-06 SAM (right).  
Images: KCTV (left), ONN (right)

## 2. Second Radar

A radar with a large antenna can also be seen behind the new hypersonic missile (Figure 13). Judging by its appearance and size, the radar is most likely a long-range search and early warning radar.



## 3. Third Radar

Another piece of equipment, presumably a radar, was also showcased for the first time at the exhibition (Figure 14). The function of this radar, which was placed between a naval gun and a rail-mobile launcher for the KN-23 ballistic missiles,<sup>8</sup> remains unknown.



Figure 13. The antenna of the radar seems not to be fully erected due to the height of the ceiling.  
Images: KCTV



Figure 14. Another piece of equipment, presumably a radar, showcased for the first time at the exhibition.

Images: KCTV, KCNA

#### 4. Fourth Radar

The exhibition revealed more information about a land-based radar system that was possibly present during live fire tests of the KN-06 SAM in April 2016<sup>9</sup> and in May 2017 (Figure 15). The radar has one main antenna

and another small antenna above its truck cabin. It remains to be seen if the antennas can rotate. The exact function of this radar remains unclear. It is possible that the radar was also part of the 30 September 2021 test of the new SAM (Figure 16).

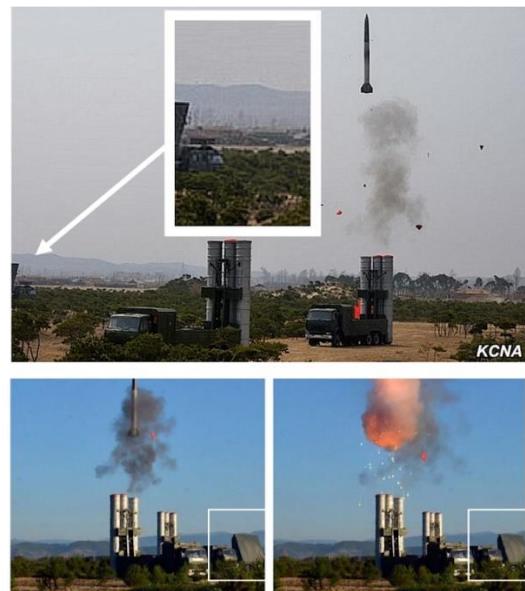


Figure 15. The radar showcased in the exhibition (left) and the radar present at the test fire of the KN-06 SAM in April 2016 (top right) and in May 2017 (bottom right). It is not known whether the KN-06 system has been brought into active service.

Images: KCNA



Figure 16. The showcased radar might have also participated in the test fire of the new SAM on 30 September 2021.

Image: KCNA

### C. Air-to-Air Missiles (AAM)

In the “tactical weapons section” [전술미싸일부분] exhibition booth, AAMs with modern aerodynamic layouts (Figure 17)

are showcased among other weapons, such as anti-tank guided missiles and man-portable air defence missiles. These AAMs, if successfully developed, could easily be converted into surface-to-air missiles.



Figure 17. The missile in the white box appears to be an infra-red homing short-range AAM. The missile in the red box appears to be a radar-homing beyond-visual-range AAM. Inset photo suggests that the short-range AAM is equipped with jet vanes to improve agility. Such a design is normally seen on very advanced short range AAMs.

Image: KCT

## D. Anti-Ship Missile (ASM)

A possible long-range anti-ship missile was showcased in front of a previously known anti-ship missile of the DPRK. This new anti-ship missile has an aerodynamic design similar to that of the cruise missile tested on 11 and 12 September 2021 which had a reported range of 1500km (Figure 18).<sup>10</sup> The use of straight wings could increase the lift for this

missile, enabling it to have a longer range. However, a long flight could only be fully utilized if the DPRK has the ability to reliably monitor vessels over a long distance.

There appear to be optical seekers at the tips of the nose cones of the new anti-ship missile and the long-range cruise missile. However, this impression could be caused by a different paint or reflection of light.



Figure 18. The long-range anti-ship cruise missile (top) and the “1500 km range” cruise missile tested on 11 and 12 September 2021 (bottom). Inset photo: an enhanced view of the tip of the long-range anti-ship missile.

Images: KCTV

## E. Anti-Tank Guided Missile (ATGM)

### 1. New ATGM

A new type of ATGM was displayed at the exhibition. Its appearance shares similarities

with the Chinese KD-10 ATGM (Figure 19). It may adapt a semi-active laser homing mode,<sup>11</sup> although the possibility of other guidance modes cannot be ruled out at this point.

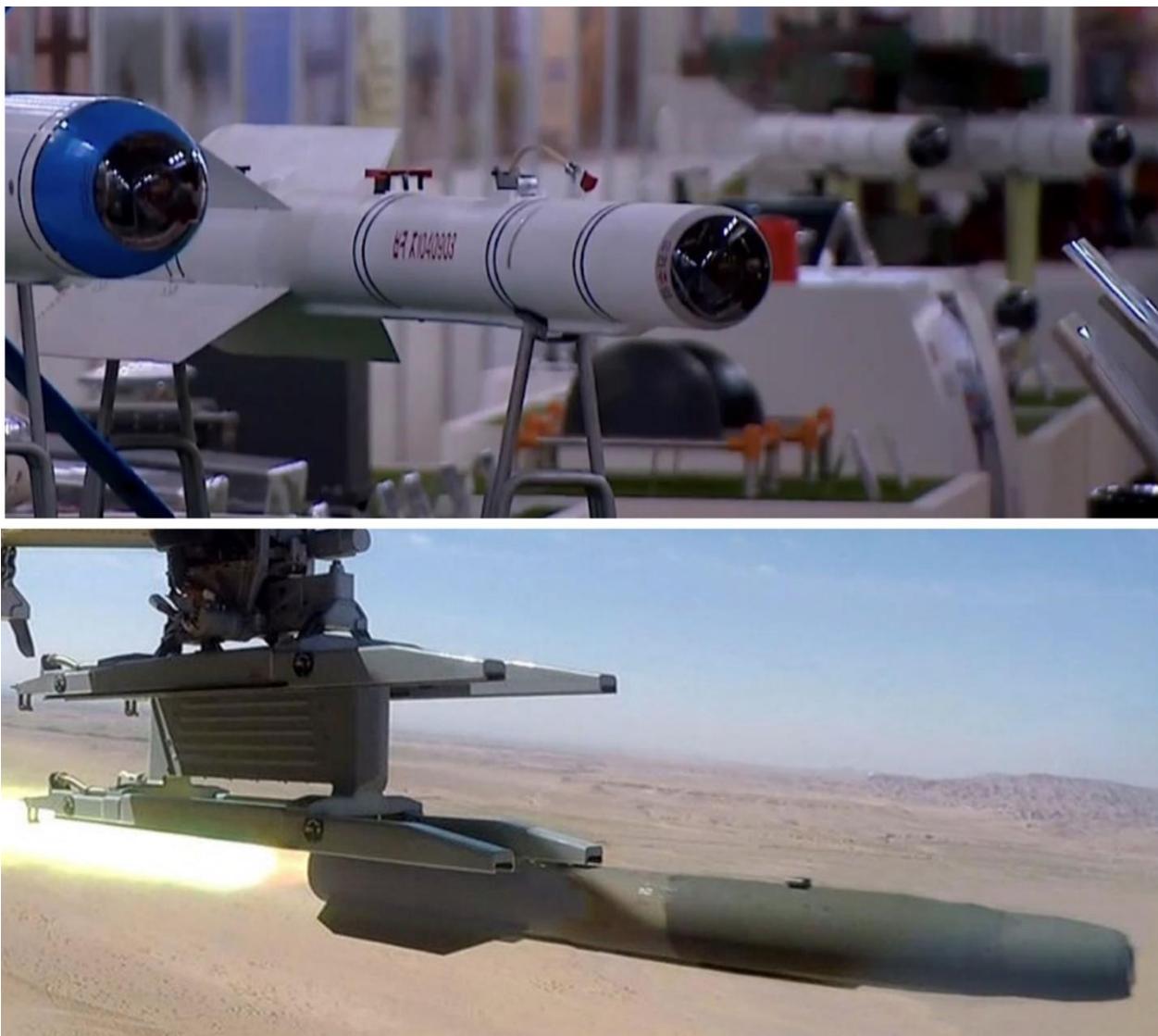


Figure 19. New ATGM displayed at the exhibition. In the background there appears to be a three-missile launcher designed for helicopters (top). A semi-active laser guided KD-10 ATGM launched from a helicopter of the Chinese army (bottom).

Images: KCTV (top), China Central Television (bottom)

## 2. Another ATGM

Another advanced ATGM possibly guided through fiber optics or a wireless data link was also shown at the exhibition (Figure 20). In this guidance mode, the missile's TV or infrared imaging seeker sends the image in real time through a two-way fiber optic cable, or a wireless data link, to the operator, who in turn steers the missile towards the target. The KCTV report on the exhibition showed a video clip of such an ATGM being launched from a

gunship. It is worth noting that similar missiles have also been deployed by front line units of the Republic of Korea.<sup>12</sup> TV or infrared imaging seeker technology could also be used for the terminal guidance of nuclear capable cruise missiles.

Speculation about the existence of this missile has circulated since 2016 after the DPRK showed a video clip taken from a missile seeker before the missile hit a target tank (Figure 21).



Figure 20. Another advanced ATGM showcased at the exhibition.

Image: KCTV



Figure 21. View from a missile's TV seeker when the missile is diving towards a tank (bottom left), target hit (bottom right).

Images: KCTV (2016 documentary)

## F. Other Armaments

Drones, satellite models (Figure 22), electro-optical equipment (Figure 23), a naval gun

with a stealth turret (Figure 24) and electronic experiment materials (Figure 25) were also displayed at the exhibition.



Figure 22. Drones and a satellite model displayed at the exhibition.

Image: KCTV



Figure 23. Electro-optical equipment shown at the exhibition (left) and identical equipment installed on a navy vessel (right).

Images: KCTV



Figure 24. A naval gun with a turret, presumably designed to reduce radar reflection, was displayed at the exhibition. The missile launcher behind it was first showcased in a parade on 10 October 2020. The purpose of this missile launcher remains unknown.<sup>13</sup>

Image: KCTV

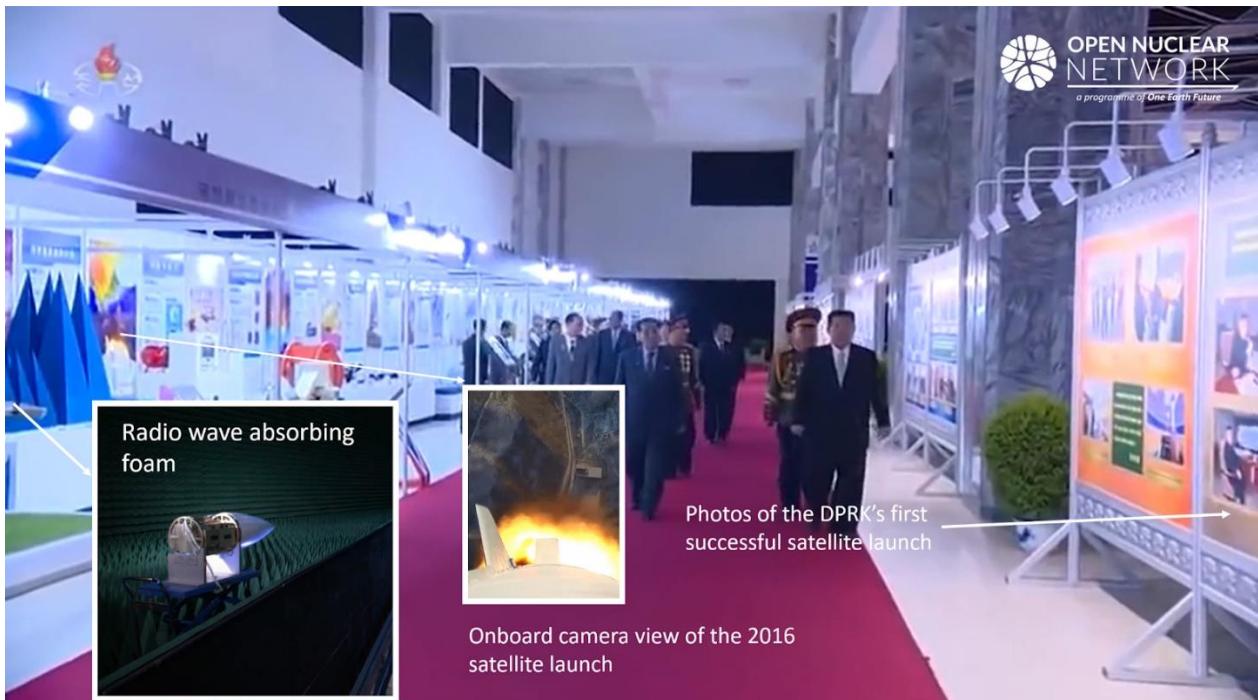


Figure 25. This booth appears to showcase achievements in the field of radio signal and aerospace industry.

Images: KCTV, KCNA, National Chung-Shan Institute of Science and Technology (inset photo on the left), annotated by ONN

### **III. CONCLUSION**

The exhibition demonstrates that, despite economic hardship and sanctions, the DPRK is continuing its investment in both nuclear and conventional arms. These weapon developments all serve the goal of converting

the DPRK's military into a sophisticated "high-tech elite force," a task set out during the Eighth Party Congress of the WPK in January 2021.<sup>14</sup>

## ENDNOTES

- 1 Tianran Xu, *Observations on the 28 September 2021 Hypersonic Missile Test of the Democratic People's Republic of Korea*, ONN, 29 September 2021, available at: <https://oneearthfuture.org/research-analysis/observations-28-september-2021-hypersonic-missile-test-democratic-peoples>
- 2 Kim Jong Un guides ballistic missile test-fire through precision control guidance system, KCNA, 30 May 2017
- 3 The other four are Pukguksong-1, Pukguksong-3, Pukguksong-4 and Pukguksong-5. See: Tianran Xu, *Ballistic Missiles Submarines and Submarine-launched Ballistic Missiles of the Democratic People's Republic of Korea*, ONN, 16 April 2021, available at: <https://oneearthfuture.org/research-analysis/ballistic-missile-submarines-and-submarine-launched-ballistic-missiles-democratic>
- 4 The other four are Pukguksong-1, Pukguksong-3, Pukguksong-4 and Pukguksong-5. See: Tianran Xu, *Ballistic Missiles Submarines and Submarine-launched Ballistic Missiles of the Democratic People's Republic of Korea*, ONN, 16 April 2021, available at: <https://oneearthfuture.org/research-analysis/ballistic-missile-submarines-and-submarine-launched-ballistic-missiles-democratic>
- 5 Tianran Xu, *Two key questions about North Korea's new missile*, Bulletin of the Atomic Scientists, 22 October 2021, available at: <https://thebulletin.org/2020/10/two-key-questions-about-north-koreas-new-missile/>
- 6 For uncontrolled ballistic flight, a projectile only needs stability in its rolling axis, like a bullet fired from a rifle. Most MRLs employ a rolling body design for this reason. However, for any aerial vehicle to maintain controlled flight, its attitude must be controlled on three axes: pitch, yaw and roll. See: *Getting on an Airplane*, December 2010, available at: [https://www.nasa.gov/sites/default/files/atoms/files/getting\\_on\\_an\\_airplane\\_k\\_2.pdf](https://www.nasa.gov/sites/default/files/atoms/files/getting_on_an_airplane_k_2.pdf)
- 7 Tianran Xu, *Preliminary Analysis of 30 September 2021 Anti-Aircraft Missile Test of the Democratic People's Republic of Korea*, ONN, 1 October 2021, available at: <https://oneearthfuture.org/research-analysis/preliminary-analysis-30-september-2021-anti-aircraft-missile-test-dprk>
- 8 Tianran Xu, Jaewoo Shin, Katsuhisa Furukawa, *The First DPRK Missile Launch from a Rail-Mobile Launcher*, ONN, 17 September 2021, available at: <https://oneearthfuture.org/research-analysis/first-dprk-missile-launch-rail-mobile-launcher>
- 9 This discovery was first made by the observer who opiates under the twitter handle @GreatPoppo: <https://twitter.com/GreatPoppo/status/1448264080775520269?s=20>
- 10 Tianran Xu, *Briefing on North Korea's 11/12 September Missile Launches*, ONN, 14 September 2021, available at: <https://oneearthfuture.org/research-analysis/briefing-north-koreas-1112-september-missile-launches>
- 11 In this guidance mode, the missile is guided by laser energy reflected from the target. A laser source (for example, a fire control station) needs to "illuminate" the target in order to generate the reflected laser energy. See: *Hellfire Family of missiles*, Weapon Systems, 2012, available at: <https://man.fas.org/dod-101/sys/land/wsh2012/132.pdf>

- 12 *South Korea deploys Israeli Spike missiles*, Korea Herald, 19 May 2013, available at: [http://www.koreaherald.com/search/list\\_name.php?byline=Korea+Herald](http://www.koreaherald.com/search/list_name.php?byline=Korea+Herald)
- 13 *Viewbook of DPRK 10 October 2020 Parade*, ONN, 13 October 2021, available at: <https://oneearthfuture.org/research-analysis/viewbook-dprk-10-october-2020-parade>
- 14 *On Report Made by Supreme Leader Kim Jong Un at Eighth Congress of WPK*, KCNA, 10 January 2021

## ONE EARTH FUTURE

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One Earth Future Foundation (OEF) is an incubator of innovative peacebuilding programs that designs, tests, and partners to scale programs that work hand-in-hand with those most affected by conflict to eliminate the root causes of war. We believe in a world beyond war, where sustainable peace is truly possible.

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One Earth Future's Open Nuclear Network programme is a non-aligned, non-governmental entity that seeks to increase security for all States by ensuring that nuclear decision makers have access to high quality, shareable open source information which enables them to make the best decisions in the face of escalating conflict.

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### CONTACT US

 +43 1 2263939       [onn@oneearthfuture.org](mailto:onn@oneearthfuture.org)

 Argentinierstrasse 21/9, 1040 Vienna, Austria

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