Sky Sentinels: A Deep Dive into S-400 and S-500 Missile Systems

Introduction

The 20th Century has seen a lot of improvements in the field of defence technology and strategies to counter the threat of a surprise attack. World War 1, World War 2, and the Cold War laid the foundation for creativity in dealing with the threat of surprise attacks, particularly by fighter aircraft. The Americans decided to work on this issue and came up with a solution that targeted the aircraft intruding into the airspace of other nations by developing anti-aircraft systems. The constant violations and intrusions into the airspace led to the development of Surface-to-Air Missiles (SAM). They're also known as Ground-to-Air Missiles or Surface-to-Air Guided Weapons. The United States (US) was the first one to successfully induct SAMs at an operational level when they inducted the Nike Ajax missiles in 1954 with a range of almost 50 km.[1] With time, the SAMs saw a rapid increase in their technology. The Union of Soviet Socialist Republics (USSR) developed the S-75 Dvina, which to date, is still the most produced SAM.[2] Widely used systems include the American Patriot System developed by Raytheon and the Soviet Union's S-300 developed by NPO Almaz, which has been codenamed SA-10 Grumble by the North Atlantic Treaty Organisation (NATO) members. The most potent system in today's world is the S-400, which was developed by the Russians after the fall of the USSR.



Figure 1: S-400 Triumf; Source: Russian Ministry of Defence

S-400 Triumf

The S-400 Triumf, also known as SA-21 (Surface-to-Air-21) Growler, which is its NATO codename, is a Surface to Air missile system developed by the Russians to tackle the increasing threat of US fighters in the aftermath of the fall of the Soviet Union.[3] It is a mobile SAM system capable of defending a country in case of an incursion or a violation of airspace by the enemy air

forces. It is capable of engaging enemy fighters/aircraft, Unmanned Aerial Vehicles, and has the capability of defending against terminal ballistic missiles and cruise missiles.

The S-400 Triumf is the 4th generation of Russian long-range SAMs and the successor to the S-300. Its mission set and capabilities are quite similar to the US' Patriot missile systems which have a Hit-to-Kill technology.[4] The S-400 works on high explosive fragmentation technology which is the 48N6 missile series and works in a way where it intercepts enemy aircraft and explodes with a lot of fragments ultimately damaging the aircraft. The Hit-to-Kill technology on the S-400 is still under development and might take some time to develop, with the 77N6 missile series giving it an edge over its adversaries in case of a conflict. The biggest advantage this SAM has over its competitors is the operational range that it offers. It has successfully tracked enemy fighters and missiles over a range of 250 km to 400 km, which in comparison to the Patriot system's range of 100 km, is a lot.[5] It can also intercept a ballistic missile within a range of 60km.

It came into service in 2007, when Russia deployed it on its borders, and it's still considered the best in its class.[6] Its development started in the year 1993, two years after the collapse of the USSR. It was frequently delayed due to the economic conditions that Russia was going through, because of the collapse of the USSR and was very often subjected to budget restrictions which delayed its induction into the Russian defence forces. Most of the technology of the S-400 is taken from the previous generations of SAMs. Around 70 to 80 per cent of its tech is taken from S-300, including missile storage containers, launchers, and radars. It's very hard to distinguish between the two due to their similarities. Even the S-400 launchers are compatible with the S-300 interceptors. Developed by Almaz Antei, it took almost 6 years to begin the testing of the S-400 SAMs. It began in late 1999/early 2000, with most of the testing done in Russia's Kasputin Yar missile range. Most of Russia's missile tests are done in the Kasputin Yar missile range due to its favourable location in the southwestern region of Russia. It was first deployed under the command of Russia's 1st Air Defence Corps. The 1st Air Defence Corps has the responsibility of defending Moscow from all kinds of aerial threats.

The S-400 is a combination of different components which when together, makes the system whole. This includes launchers, interceptors, radars, and missile storage containers. It primarily uses the 48N6 missile series. This missile series allows the system to hit aerial targets up to a range of 250 km. It can also target ballistic missiles up to a range of a 60 km radius and destroys them using a 143 kg high explosive fragmentation warhead, which explodes in close proximity to its aerial target. Another missile series that is currently under testing is the 77N6 missile series, which will use the fatal Hit-to-Kill technology in its interceptors. This technology is designed to tackle the threat of ballistic missile warheads, which need to be intercepted and destroyed as soon as possible in case of an attack. The final missile series is the 40N6 missile series. This missile series has a much longer range and extends the air defence capability of the S-400 system to a 400 km range. The deployment status of the 40N6 missile series is currently unclear, and this seems to be an issue as this missile series allows the S-400 to make full use of its full range.

The S-400 system augmented the S-300 system after its deployment and helped Russian forces in defending their country against external threats. Due to its great success, it created a demand for its export to other countries. Countries like India, China and Turkey placed orders to get these systems to protect their airspaces from external forces. India and Russia came to an agreement in 2018, in which 5 battalions of S-400 systems were bought by India for 5 billion dollars.[7] China also bought 6 battalions of this system to fend off its external threats.[8] Turkey

also bought the S-400 system from Russia, even after facing a lot of sanctions from Western countries, particularly the US. Turkey was kicked out of the Joint Strike Fighter program by the US, which produced the F-35 Lightning II.[9] It was a big blow to Turkey, which had invested more than a billion in the project. But this shows how important the S-400 is to Turkey, which despite being a NATO country, opted for a Russian SAM system. The S-400 system will continue to be a very important part of the defence of the abovementioned nations.

S-500 Prometheus

The next generation of SAM systems is the S-500 Prometheus, which is also known as the 55R6M 'Triumfator M'.[10] It is the 5th generation of SAM defence systems. Just like the S-400, this is also a mobile SAM system. It is currently under development, and it is being developed by Almaz Antei, the same company that developed the S-400 system. It is to counter aircraft, ballistic and cruise missiles and reportedly, it can also counter the threat of low-orbit satellites by targeting them.

It is both originated and possessed by Russia, which is responsible for its development. It is a ground-based, mobile SAM system. This system will be a game changer in the field of air defence as its range has been increased to 500 to 600 km. This means a lower number of SAM systems are needed to protect a large area. It has been speculated that only 3 SAM systems are needed to protect the Russian border and installations on its western periphery. Its development started in 2010, just after the deployment of S-400 systems (2007). It is reportedly capable of destroying 5th generation fighters, which at the moment are seen as invincible. It can also destroy low-orbit satellites, in addition to cruise and ballistic missiles which could be dealt with by the S-400 and S-300 systems. Its design and development are overseen by the Russian enterprise Almaz Antei. It has faced significant delays in its development. After its design development was completed in 2011, its serial production was shifted from 2014 to 2017, to 2021, and finally to 2025. It has been speculated that the Russians are purposefully delaying the S-500 induction to continue the production lines of the S-400 and continue with its exports.



Figure 2: S-500 AD system; Source: Sputnik News

The Russians have already conducted a lot of test launches of the S-500 system. The Russian media reported in May 2018 that Russia has conducted "The world's longest Surface to Air Missile test" using the S-500 system, striking a target nearly 482km (300 miles) away.[11] It is speculated that Russia will be developing an export version as well, to cater for the specific needs of its ally countries. Prospective buyers can again be India, China, and Turkey, who are more than happy with their current systems. Russian deputy defence minister recently announced that India could be the first buyer of the S-500 systems. In May 2019, Turkish President Recep Erdo?an announced that Turkey would jointly produce the S-500 systems with Russia.[12]

It is reported that Russia plans on fielding 10 battalions of S-500. In Apr 2021, Russian media reported that specialist air defender training on S-500 is already underway. S-500 is capable of launching several types of interceptors. 40N6M missile series can be used against aircraft and cruise missiles. The new 77N6 and 77N6-N1 can be used against ballistic missiles and satellites. 40N6M has an operational range of around 400km whereas the 77N6 interceptor works in an operational range of around 500 to 600km. This provides the S-500 with a great advantage over its adversaries.



Figure 3: S-500 AD systems; Source: Russian Ministry of Defence

There are four radar vehicles per battery:

- 1. 91N6E(M) S-Band acquisition radar.
- 2. 96L6-TsP C-Band acquisition radar.
- 3. 76T6 multi-made engagement radar.
- 4. 77T6 Anti-Ballistic Missile engagement radar.

This radar complex allows the S-500 system to detect ballistic missiles up to 2,000 km range and airborne targets up to 800 km range. It was also reported by Russian media in Jun 2021 that

the S-500 system will be equipped with interceptors that can even intercept supersonic weapons.

Conclusion

It remains to be seen how Russia will be navigating forward when it comes to its SAM defence systems. Both S-400 and S-500 have the capability to turn a war in their user's favour. With Russia already bogged down in Ukraine and facing the whole world's wrath, all the eyes are on its manufacturing might, and whether it will be able to deploy S-500 to gain an advantage on the battlefield.

References:

1. Ancile. (2023). Deagel.com. <u>https://www.deagel.com/Artillery%20Systems/MIM-104%20Patriot/a000603#001</u>

2. S-400 Triumf. (n.d.). Missile Threat. https://missilethreat.csis.org/defsys/s-400-triumf/

3. *S-500 Prometheus*. (n.d.). Missile Threat. Retrieved April 8, 2023, from https://missilethreat.csis.org/defsys/s-500-prometheus/#easy-footnote-bottom-11-1916

4. *TASS: Russia - New-generation missile destroyer under development in Russia*. (24th Oct 2014). Web.archive.org. <u>https://web.archive.org/web/20141024041212/http://en.itar-tass.com/russia/755539</u>

5. Williams, I. (3 Jan 2017). *The Russia - NATO A2AD Environment | Missile Threat*. Missile Threat. <u>https://missilethreat.csis.org/russia-nato-a2ad-environment/</u>

6. Wilson, P. A., & Parachini, J. V. (6 May 2020). *Russian S-400 Surface-to-Air Missile System: Is It Worth the Sticker Price?* www.rand.org

https://www.rand.org/blog/2020/05/russian-s-400-surface-to-air-missile-system-is-itworth.html

7. Ahval News, "Erdo?an says Turkey will produce new generation S-500 with Russia," 19 May 2019,

https://ahvalnews.com/s-500/erdogan-says-turkey-will-produce-new-generation-s-500-russia

8. Roger McDermott, "Moscow Weighs Options to Procure S-500 Air-Defense Systems", Jamestown Foundation, 24 Mar 2021, <u>https://jamestown.org/program/moscow-weighs-options-to-procure-s-500-air-defense-systems/</u>.

9. Joseph Trevithick, "Russia's S-500 Air Defense System Reportedly Hits Target Nearly 300 Miles Away", The Drive, 24 May 2018, <u>https://www.thedrive.com/the-war-zone/21080/russias-s-500-air-defense-system-reportedly-hits-target-nearly-300-miles-away</u>

End Notes

[1] Grant, "Nike Ajax: How the first surface-to-air missile changed warfare forever", Airforce Technology, 14 Oct 2013,

Nike Ajax: How the first surface-to-air missile changed warfare forever - Airforce Technology (airforce-technology.com)

[2] Gupta, Anchit, "The S-75 Dvina – India's first Surface to Air Guided Weapon", Bharat Rakshak, 19 Oct 2018,

The S-75 Dvina – India's first Surface to Air Guided Weapon – Bharat Rakshak (bharatrakshak.com)

[3] Missile Defense Project, "S-400 Triumf," Missile Threat, Center for Strategic and International Studies, 4 May 2017, last modified 6 Jul 2021,

https://missilethreat.csis.org/defsys/s-400-triumf/.

[4] "PATRIOT Advanced Capability-3 (PAC-3)", Missile Defence Agency (US DoD),

MDA - PATRIOT Advanced Capability-3 (PAC-3)

[5] Missile Defense Project, "S-400 Triumf," Missile Threat, Center for Strategic and International Studies, 4 May 2017, last modified 6 Jul 6 2021,

https://missilethreat.csis.org/defsys/s-400-triumf/

[6] Missile Defense Project, "S-500 Prometheus," Missile Threat, Center for Strategic and International Studies, 4 May 2017, last modified Jul 1, 2021,

https://missilethreat.csis.org/defsys/s-500-prometheus/

[7] Peri, Dinakar, "India signs \$5.43 billion S-400 missile deal with Russia", The Hindu, 05 Oct 2018,

India signs \$5.43 billion S-400 missile deal with Russia - The Hindu

[8] "Russia Announces Sale of S-400 to China", CSIS, 30 Jun 2014,

Russia Announces Sale of S-400 to China | The Post-Soviet Post | CSIS

[9] Marcus Jonathan, "US removes Turkey from F-35 Fighter Jet Programme", BBC, 18 Jul 2019,

US removes Turkey from F-35 fighter jet programme (bbc.com)

[10] Missile Defense Project, "S-500 Prometheus," Missile Threat, Center for Strategic and International Studies, 4 May 2017, last modified 1 Jul 2021,

https://missilethreat.csis.org/defsys/s-500-prometheus/

[11] Trevithick, Joseph, "Russia's S-500 Air Defense System Reportedly Hits Target Nearly 300 Miles Away", The WarZone, 24 May 2018,

Russia's S-500 Air Defense System Reportedly Hits Target Nearly 300 Miles Away (twz.com)

[12] "Erdo?an says Turkey will produce new generation S-500 with Russia", Ahval, 19 May 2019,

Erdo?an says Turkey will produce new generation S-500 with Russia | Ahval (ahvalnews.com)

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