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Risk Report

S-500 PROMETHEUS: RUSSIAN MISSILE TECHNOLOGY AND NATO IMPACT

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RISK REPORT

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Summary

This Risk Report covers the forthcoming S-500 Prometheus (Russian: С-500 Прометей) missile system produced by Russia. An overview of its composition and projected capabilities are first covered. This is followed by a breakdown of the declared missile versatility of the S-500 missile system and a comparison to the preceding S-400 missile system. Strategic placements of the S-500 are provided with particular emphasis placed on the potential for Russia to expand its area of influence. An examination of defense spending is subsequently provided along with current counters to the S-500 missile system that are produced by the United States of America (USA) and the North Atlantic Treaty Organization (NATO). The closing thoughts summarize the significance of Russia producing such a missile system while touching upon current geopolitical implications, potential markets for selling the missile system, and projections for international tensions surrounding the hardware.

TAGS: RUSSIA, NATO, DEFENSE, GOVERNMENT, INTELLIGENCE, INTERNATIONAL AFFAIRS, INTERNATIONAL POLITICS, INTERNATIONAL RELATIONS, POLITICS, RISK, SECURITY, DEFENSE AND SECURITY, GOVERNMENT AND INTERNATIONAL AFFAIRS.

List of Abbreviations:

A2/AD	Anti-Access and Area Denial
ABM	Acquisition Battle Management
AWACS	Airborne early Warning and Control System
CAATSA	Countering America's Adversaries Through Sanctions Act
CIS	Commonwealth of Independent States
CSTO	Collective Security Treaty Organization
GDP	Gross Domestic Product
GMD	Ground-based Midcourse Defense
GSS	Global Surveillance and Strike
ICBM	Intercontinental Ballistic Missile
IRBM	Intermediate-Range Ballistic Missile
ISIL	Islamic State of Iraq and the Levant
ISTAR	Intelligence, Surveillance, Target Acquisition, and Reconnaissance
JADS	Joint Air Defense System
MRBM	Medium-Range Ballistic Missile
NATO	North Atlantic Treaty Organization
SAM	Surface-to-Air Missile
SRBM	Short-Range Ballistic Missile
UAV	Unmanned Aerial Vehicle

Introduction

Russian air and missile defense technology has been spotlighted in the headlines rather frequently in recent years, and for good reason. In 1997, Russia's planned sale of the S-300 air and missile defense system to the Greek Cypriot government made headlines when Turkey threatened to launch a preemptive strike if the S-300 system was delivered[1]. More recently, Russia's S-400 air and missile defense system gathered the attention of NATO, with Russia reaching agreements to sell this system to Turkey, China, and India. These purchases of the S-400 system are of great significance, as they come with the promise of U.S. sanctions that are intended to discourage the purchase of such military weaponry from Russia. Most notably, Turkey's purchase of the S-400 system raised great concern, given that Turkey is a member of NATO, a traditional adversary to Russia. Though the S-400 system may have the world's attention at the moment, it may pale in comparison to what is coming next. Russia's next generation of surface-to-air missile (SAM) technology, the S-500, is estimated to be the most advanced system of its kind and will undoubtedly be a prime concern for NATO.

S-500 Prometheus Profile

The S-500 Prometheus (Russian: С-500 Прометей), also referred to as the 55R6M Triumfator-M, is a Russian-made, ground-transported, defense-oriented, surface-to-air missile system that is designed to target and destroy aircraft, missiles, and unmanned aerial vehicles (UAV). Manufactured by Almaz-Antey, the S-500 commenced its testing in 2015 and began production in 2017[2]. This system is expected to reach complete field readiness by 2020, with Russia subsequently receiving five of its first ten S-500 systems that year[3]. Far more complex than photos would have you believe, the S-500 system consists of several components. Exact details on the components remain unconfirmed, however the S-500 system is reported to include the following[4]:

- 77P6 Self-propelled Transporter Erector Launcher (launch vehicle)
- 55K6MA and 85Zh6-2 Self-propelled Command Posts

[1] MISSILE DISPUTE THREATENS CYPRUS TRUCE
[2] MILITARY-TODAY: S-500 LONG-RANGE AIR DEFENSE AND ANTI-BALLISTIC MISSILE SYSTEM
[3] RUSSIA'S S-500: THE ULTIMATE WEAPON AGAINST AMERICAN MISSILES OR PAPER TIGER?
[4] AIR POWER AUSTRALIA: ALMAZ-ANTEY S-500 TRIUMFATOR M

- 91N6A(M) "Big Bird" Acquisition and Battle Management (ABM) Radar
- 96L6-TsP Acquisition Radar
- 76T6 Multimode Engagement Radar
- 77T6 AMB Engagement Radar
- 40V6MT Universal Mobile Mast System

The exact number of troops required to operate the S-500 will vary depending on the active components for the system in place. Additionally, photos and diagrams of the S-500 indicate that each launch vehicle carries two missiles at a time.

Projected Capabilities

While the full capabilities and performance specifications have not yet been disclosed by the Russian government, reports from testing indicate that the S-500 system exhibits some impressive capabilities. Reaching a remarkable attack range of 500-600 kilometers[5], the S-500 is reportedly the most advanced system of its kind. With the ability to reach targets at an altitude of 180-200 kilometers[6], the S-500 is capable of engaging intercontinental ballistic missiles (ICBM) and low-orbit satellites in Earth's thermosphere. Therefore, this system is capable of destroying an ICBM before the warhead re-enters Earth's troposphere. Additionally, the S-500 is reportedly capable of destroying cruise missiles, helicopters, and airborne early warning and control systems (AWACS)[7]. Reaching far beyond its attack range, the S-500's detection range is estimated to be 2,000 kilometers[8]. Perhaps even more impressive is that this system is capable of responding to threats under 4 seconds and simultaneously attacking up to 10 ballistic missile warheads traveling at hypersonic speeds of 5-7 kilometers per second[9]. This capability far exceeds its predecessor, the S-400, which responds to threats in under 10 seconds and attacks 6 targets within a range of 400 kilometers. Also smaller and more maneuverable than its predecessor, the S-500 maintains a set-up

[5] CSIS MISSILE DEFENSE PROJECT: S-500 AT A GLANCE
[6] RUSSIAN S-500 PROMETHEUS BALLISTIC MISSILE DEFENSE TO BE DEPLOYED IN 2016
[7] SPUTNIK: WHY IS RUSSIA'S S-500 MISSILE SYSTEM SECOND TO NONE?
[8] MILITARY-TODAY: S-500 LONG-RANGE AID DEFENSE AND ANTI-BALLISTIC MISSILE SYSTEM
[9] MISSILE THREAT: S-500 PROMETHEUS

to launch time of just 10 minutes[10], allowing it to quickly engage targets and relocate as needed. The S-500 is also likely to use a liquid propellant.

One other new capability that the S-500 will possess is the ability to shield itself from electronic warfare. Reports note that this system will utilize electromagnetic interference sensors that can mask its presence from satellites[11]. Furthermore, the S-500 features advanced communications systems with secured communication links on variable frequencies that shield itself from electronic warfare[12]. Comprehensively, this system exhibits both groundbreaking hardware and software, making it truly a next generation weapon system.

Perhaps of greatest concern for NATO is the question of the S-500's ability to target 5th-generation stealth-enabled aircraft such as the U.S.-operated F-35 Lightning II and F-22 Raptor. Unfortunately, this capability has not yet been tested, so one can only speculate on this issue. However, given the S-500's many improvements over its predecessor, it is entirely possible to surmise that the S-500 has an increased ability to identify stealth-enabled fighter jets. It is also possible that by networking together several high-speed long wave radars, the S-500 would be able to identify and target stealth-enabled aircraft like the F-35[13]. While this sensor fusion presents a theoretically valid tactic, there is no evidence to substantiate this claim. What can be determined is that the extensive range of the S-500 holds the capability to force all other aircraft, including AWACS, to operate outside of its engagement radius of 600 kilometers, creating a massive no-fly zone up to 1,200 kilometers in diameter.

System Versatility and Comparisons

The S-500 is capable of utilizing a few different missile types, allowing for a notably versatile system. Reportedly able to launch 77N6-N, 77N6-N1, 40N6, 48N6, and 9M96, missiles, the S-500 can engage targets at long, medium, and short ranges, depending on the missile used *(Figure 1)*. Specifically designed for Russia's most advanced air and missile defense systems, the 77N6-N and 77N6-N1 are reportedly able to travel at hypersonic speeds of 5-7 kilometers per second, allowing

[10] MILITARY-TODAY: S-500 LONG-RANGE AID DEFENSE AND ANTI-BALLISTIC MISSILE SYSTEM
[11] RUSSIA'S S-500: THE ULTIMATE WEAPON AGAINST AMERICAN MISSILES OR PAPER TIGER?
[12] RUSSIA BEYOND: ENEMIES WILL NOT BE ABLE TO LISTEN IN ON RUSSIA'S NEW S-500 SYSTEM
[13] RUSSIA'S S-500: HOW PUTIN COULD KILL AIR FORCE F-22S AND B-2 STEALTH BOMBERS?

them to intercept hypersonic cruise missiles[14]. These missiles will utilize a hit-to-kill method, meaning they will directly attack targets through physical impact as opposed to relying on a fragmentation warhead[15]. The capabilities of these hypersonic missiles are what give the S-500 its impressive target range of up to 600 kilometers. The 77N6-N and 77N6-N1 are intended to be the S-500 system's primary tool against ballistic missile threats, however much is still unknown about these missiles as they are reportedly still in production[16].

Additionally, the S-500 system is capable of deploying missiles that were originally designed for its S-400 predecessor[17]. For medium-range targets, the S-500 can deploy a 40N6 missile reaching targets at 380 kilometers[18], or a 48N6 missile reaching targets out to 250 kilometers. For short-range targets, the S-500 can deploy 9M96 missiles, which can reach targets up to 120 kilometers[19].

With the inclusion of the S-500 system into Russia's air defense arsenal, they are now better equipped to counter strategic, operational, and tactical missile threats. According to the Federation of American Scientists, the Russian military categorizes missiles into five range classes[20]:

- Strategic – over 1,000 kilometers
- Operational-Strategic – 500 to 1,000 kilometers
- Operational – 300 to 500 kilometers
- Operational-Tactical – 50 to 300 kilometers
- Tactical – up to 50 kilometers

The strategic range typically refers to long-range targets such as ICBMs that travel at a speed of up to 7 kilometers per second. Falling into this category of missile defense would be the S-500. The operational range refers to medium-range targets traveling up to 3 kilometers per second. Capable of handling this type of target is Russia's S-400 system. Short-range threats moving at speeds of 1.5 kilometers per second would be identified under the tactical range. Systems targeting these threats would include Russia's S-300. The composition of multiple air defense systems will best allow Russia

[14] MISSILE THREAT: S-500 PROMETHEUS
[15] RUSSIA'S S-500: THE ULTIMATE WEAPON AGAINST AMERICAN MISSILES OR PAPER TIGER?
[16] MISSILE THREAT: S-500 PROMETHEUS
[17] RUSSIA BEYOND: RUSSIA TO ROLL OUT NEW HYPERSONIC MISSILES
[18] MISSILE THREAT: RUSSIAN ARMY ACCEPTS 40N6 MISSILE FOR S-400
[19] ARMY TECHNOLOGY: S-400 TRIUMPH AIR DEFENSE MISSILE SYSTEM
[20] FEDERATION OF AMERICAN SCIENTISTS: BALLISTIC MISSILE BASICS

to manage various types of incoming aerial threats. However, an S-500 system equipped with multiple missile types and placed in a strategic location, would also be capable of managing a variety of incoming aerial threats.

Purpose and Placements

Reports indicate that Russia intends to use the S-500 system to form a defensive shield around Moscow.[21] The S-500 will be replacing the A-135 anti-ballistic missile system already in place. Additionally, the S-500 was not designed with the intent to replace its predecessor, but rather to complement the S-400's short and medium range effectiveness. Overall, Russia intends to create a multi-layered air and missile defense system that effectively forms an umbrella of air defense around particular strategic regions.[22] The S-500, when integrated with Russia's existing air and missile defense system, will prevent against short (SRBM), medium (MRBM), and intermediate range ballistic missiles (IRBM), in addition to ICBMs, thus protecting a designated territory from incoming threats, even those launched 5,500 kilometers away.[23] This inhibition of military activity into an area of operations and denial of action within areas under opposition control is referred to as "anti-access area denial" or A2/AD. Russia has and will use this strategy to directly oppose local and regional interests of the United States and its allies.[24] Russia will undoubtedly use the S-500 to augment this A2/AD strategy, preventing the United States and its allies from reacting to threats and impeding their ability to project power. Russia's increased military assertiveness has already allowed the existence of this A2/AD strategy in a vast network that spans from Murmansk in the Arctic to Tartus in the Levant. This includes Russian air and missile defense systems in the Baltic, Black Sea, and Caspian Sea regions.

Besides Moscow, there are several potential placement points for the S-500 system that would prove troublesome for the United States and its NATO allies. The closest potential placement option in proximity to NATO is Russia's European enclave, Kaliningrad Oblast. This tiny piece of Russian territory, surrounded by NATO members Poland and Lithuania as well as the Baltic Sea, is a

[21] MILITARY-TODAY: S-500 LONG-RANGE AID DEFENSE AND ANTI-BALLISTIC MISSILE SYSTEM
[22] RUSSIA'S DEADLY S-500 AIR-DEFENSE SYSTEM: READY FOR WAR AT 660,000 FEET
[23] FEDERATION OF AMERICAN SCIENTISTS: BALLISTIC MISSILE BASICS
[24] RUSSIA'S ANTI-ACCESS AREA DENIAL

significant strategic location given its ability to cast Russia's A2/AD strategy near the heart of Europe. Placement of the S-500 system here would allow Russia to target NATO aircraft within a range of 600 kilometers of this enclave *(Figure 2)*. Consequently, Russian air defense could reach the skies over Estonia, Latvia, Lithuania, Poland, Belarus, and even Berlin, Germany. The S-500 system would be integrated with S-300 and S-400 systems already in place[25], in addition to a variety offensive systems such as the Iskander SRBMs, the SS-N-3 "Shaddock" and SS-N-25 "Switchblade" coastal defense systems, as well as SS-N-27 "Sizzler" and SS-N-26 "Strobile" cruise missiles[26].

Another critical placement point could be the Ukrainian peninsula of Crimea, which Russia annexed in 2014. It is widely acknowledged by the international community that Russia and its military control this territory. Placement of the S-500 in Crimea would allow Russia to shield any future operations in Ukraine from aerial threats *(Figure 3)*. The extensive range of the S-500 would even allow it to strike aerial targets over the majority of the Black Sea. Integration with S-300 and S-400 systems already in place would further support A2/AD strategy and operations in Ukraine and the Black Sea by impeding NATO action there.

Perhaps the most significant placement point from a military perspective would be either Russia's naval base in Tartus, Syria, or their air base in Khmeimim, Syria *(Figure 4)*. Russia's support of the Assad regime in Syria has placed Russia at odds with much of the international community. While it is highly unlikely that Russia would use its air defense systems to target NATO aircraft in Syria, an S-500 system placed at either Tartus or Khmeimim would be able to protect the skies over the entirety of the Syrian territory under Assad's control. Russia has already delivered its S-300 system to Syria in September of 2018, reportedly in response to Israel downing a Russian aircraft[27]. Therefore, it is feasible that Russia could also place the S-500 system within Syria in the future. The placement of Russia's older air and missile defense systems in Syria affirms Russia's intent to defend the airspace above Assad's forces. Moreover, the placement of the S-500 system in Syria would likely deter a repeat of the joint precision missile strike carried out by U.S., British, and French forces in April of 2018[28].

[25] MISSILE THREAT: S-400
[26] RUSSIA'S ANTI-ACCESS AREA DENIAL
[27] RUSSIA TO SEND S-300 MISSILE DEFENCE SYSTEMS TO SYRIA
[28] WHAT WE KNOW ABOUT THE U.S. AIRSTRIKES ON SYRIA

Some experts theorize that one of Russia's long-term objectives is to unify their air and missile defense system with other nations in the Commonwealth of Independent States (CIS)[29]. This strategy would be to realize a CIS Joint Air Defense System (CIS JADS) which would form a missile defense perimeter around a massive amount of territory. The future integration of Russia's S-500 system into the CIS JADS is not entirely unrealistic, given that most of the participating member states also make up the Collective Security Treaty Organization (CSTO), Russia's collective opposition to NATO. Therefore, Russia could potentially integrate its S-500 system with air and missile defense systems already established in Belarus, Armenia *(Figure 5)*, Kazakhstan, Kyrgyzstan *(Figure 6)*, or Tajikistan. A fully-integrated air and missile defense system with Russia's allied nations would drastically increase the extent of monitored territory and its A2/AD strategy. In addition to their military presence in Kaliningrad, Ukraine, and Syria, Russian maintains several military bases outside its borders. Therefore, the S-500 system could potentially be placed in the following locations[30]:

- 102nd Military Base in Gyumri, Armenia.
- Hantsavichy Radar Station near Baranovichi, Belarus.
- 7th Krasnodar Red Banner Military Base in Abkhazia, Georgia.
- Anti-ballistic missile testing range in Sary-Shagan, Kazakhstan.
- Kant Air Base near Bishkek, Kyrgyzstan.
- 201st Military Base in Dushanbe, Tajikistan.

Figure 7 illustrates the magnitude of potentially setting up S-500 missile systems in the aforementioned areas.

Proliferation

Thus far, Russia has shown no indication of their intent to sell the S-500 system to other nations. At the moment, Russia appears to be content with selling the older S-400 system to China,

[29] RUSSIA'S MILITARY COOPERATION GOALS IN CENTRAL ASIA
[30] RUSSIAN MILITARY BASES ABROAD: FACTS AND DETAILS

India, Turkey, and other nations seeking to expand their air defense arsenal such as Saudi Arabia or Qatar. However, Russia has established that they are capable of producing a highly functional air and missile defense system and they are offering more competitive prices than their competition. Furthermore, Russia has established itself as a rival to the United States in global arms trade, with potential clients across the globe. In 2013, Russia sold an estimated total of $29.7 billion of arms to countries on virtually every continent, including China, Belarus, Algeria, Venezuela, and Mexico[31]. The price per unit of the S-500 is estimated to cost roughly $450-500 million per fire unit[32]. Potential buyers must also take into consideration the cost of U.S. sanctions. Since August of 2017, the United States discourages states from purchasing weapons systems from Russia through the Countering America's Adversaries Through Sanctions Act (CAATSA)[33]. Despite these sanctions, the proliferation of Russian air and missile defense systems is likely to continue. Many nations like Turkey, China, and India have shown interest in working closer with Russia regardless of the threat of U.S. sanctions.

Defense Spending

One comparison that brings concern is that of defense spending between the United States and Russia. In 2017, the United States spent an estimated $602.8 billion on defense, which amounts to around 3.11% of US GDP. During this time, the U.S. was engaging in military operations in Afghanistan and against the Islamic State of Iraq and the Levant (ISIL). In the same year, Russia only spent an estimated $6.12 billion on defense, which amounts to 4.17% of their GDP. Actively engaged in military involvements in Ukraine and Syria, Russia has been able to accomplish a significant amount from a military perspective, despite this comparatively low defense budget. While dwarfed by a U.S. budget of over $600 billion, Russia has carefully focused its spending on advancing capabilities in crucial areas such as their air defense systems and amplifying their A2/AD strategy[34]. Russian President Vladimir Putin is working to modernize his military force, looking at methods of countering NATO power projection through alternative methods, such as an extensive overlapping air defense network spanning from the artic to the Levant.

[31] MAP OF US AND RUSSIAN ARMS SALES
[32] THE PRICE OF RUSSIAN WEAPONS
[33] COUNTERING AMERICA'S ADVERSARIES THROUGH SANCTIONS ACT
[34] RUSSIA'S ANTI-ACCESS AREA DENIAL

USA and NATO Counters

While the S-500 system will by no means tip the global power scale away from the U.S. and NATO, it does however amplify Russia's A2/AD strategy, severely limiting NATO operations in Russian-controlled areas. On the flipside of this coin, the United States and NATO maintain an A2/AD strategy of their own. The United States utilizes ballistic missile defense systems that target incoming threats both in the midcourse segment of flight, such as the AEGIS naval ballistic missile defense or the Ground-based Midcourse Defense (GMD) system, as well as the terminal segment of flight, such as the Terminal High Altitude Area Defense (THAAD) system or the Patriot Advanced Capability-3 (PAC-3)[35]. With a detection range of 600 kilometers and an attack range of 400 kilometers[36], the THAAD is NATO's most comparable air defense system to the Russian S-500 *(Figure 8)*.

Even with Russia's new S-500 system, the U.S. and its $600 billion defense budget are not without options. In order to counteract Russia's A2/AD strategy, U.S. and its NATO allies can leverage their advantages in other areas such as unmanned systems, low-observable air operations, or undersea warfare[37]. In their 2014 report, the Center for Strategic and Budgetary Assessments identified this strategy to offset Russia's military modernization program by creating a global surveillance and strike (GSS) network. Consistent with this GSS network, NATO must continue to develop advanced stealth technology that will allow for continued operation within the S-500 system's extensive range. Thus far, Lockheed Martin's F-35 Lightning II fighter jet has been designed with advanced stealth technology, leaving us to wonder if such an aircraft could slip past an S-500 unnoticed.

Conclusion

The U.S. and its NATO allies will rightfully be concerned with this latest tech coming from Russia. Admittedly, it is too soon to tell what the exact capabilities of the S-500 system are, yet the projected capabilities will assuredly make this air and missile defense system a game changer in its field. The inclusion of the S-500 system into the conflicts of Syria or Ukraine would further inhibit

[35] MDA BALLISTIC MISSILE DEFENSE SYSTEM
[36] ARMY TECHNOLOGY: THAAD
[37] CSBA: A STRATEGY TO SAVE U.S. MILITARY SUPERIORITY

NATO involvement in these theaters. Moreover, integrating the S-500 with the air defense networks of Russia's allied nations would allow for a substantial increase in the scope of A2/AD strategy, thus expanding a territorial wall of NATO inoperability. The massive range and capability of this system is likely to catch the eye of future potential buyers, consequently allowing the spread of Russian influence as it has with the S-400 system. Simply stated, the S-500 system is a powerful tool for the future of Russia's strategic goals and should not be overlooked or underestimated.

Figures

Unit	S-500	S-400	S-300	THAAD	MIM-104
Country	Russia	Russia	Russia	USA	USA
Year Developed	2020*	2007	1997	2008	1985
Detection Range	2,000 km	600 km	300 km	1,000 km	100 km
Attack Range	600 km	400 km	150 km	200 km	70 km
Max Altitude	200 km	30 km	30 km	150 km	25 km
Standard Missile	77N6-N	40N6	48N6E	THAAD	*PAC-1

Figure 1: Chart covering missile system units, the associated producing country, the year of development or projected year of development, detection range of the missile system, attack range of the missile system, declared maximum altitude capability, and standard missile outfit.

**** MIM-104 Systems currently utilize PAC-3 missiles with improved capabilities.***

Figure 2: Theoretical S-500 missile system placement and associated range potential from Kaliningrad, Russia.

Figure 3: Theoretical S-500 missile system placement and associated range potential from Crimea, Ukraine.

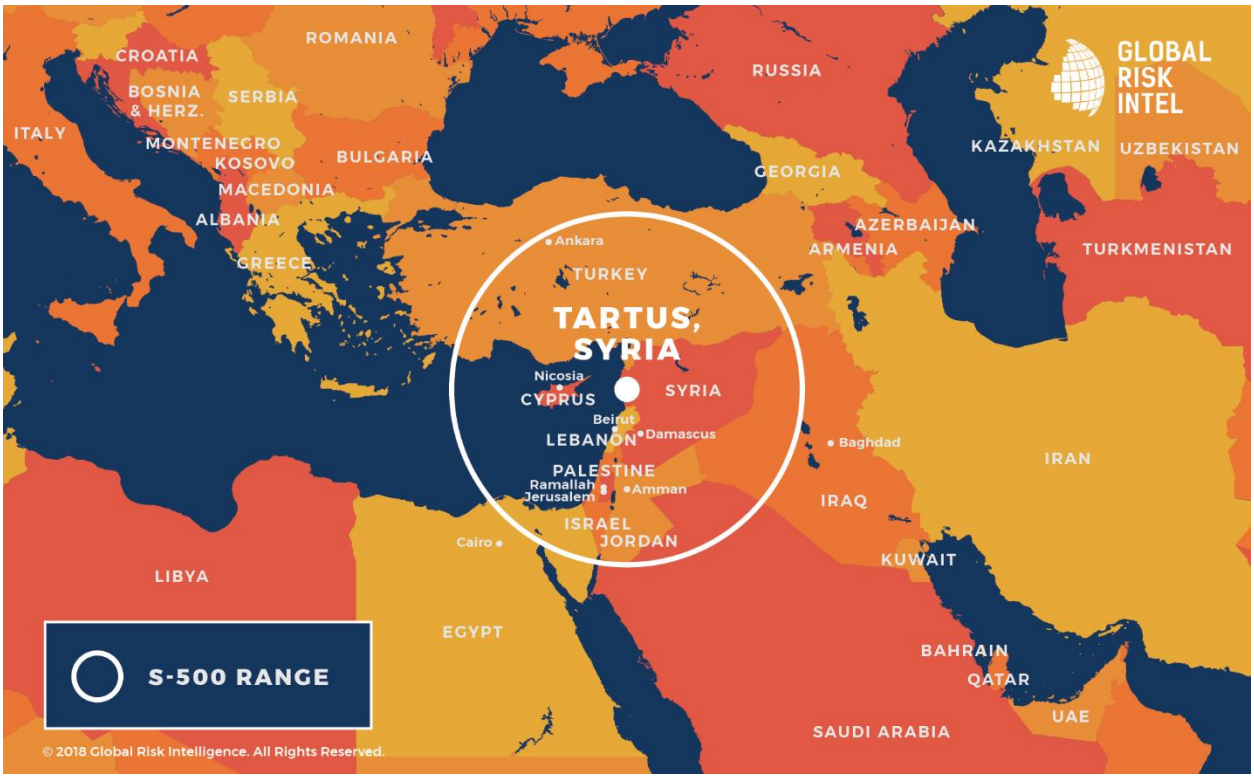

Figure 4: Theoretical S-500 missile system placement and associated range potential from Tartus, Syria.

Figure 5: Theoretical S-500 missile system placement and associated range potential from Yerevan, Armenia.

Figure 6: Theoretical S-500 missile system placement and associated range potential from Bishkek, Kyrgyzstan.

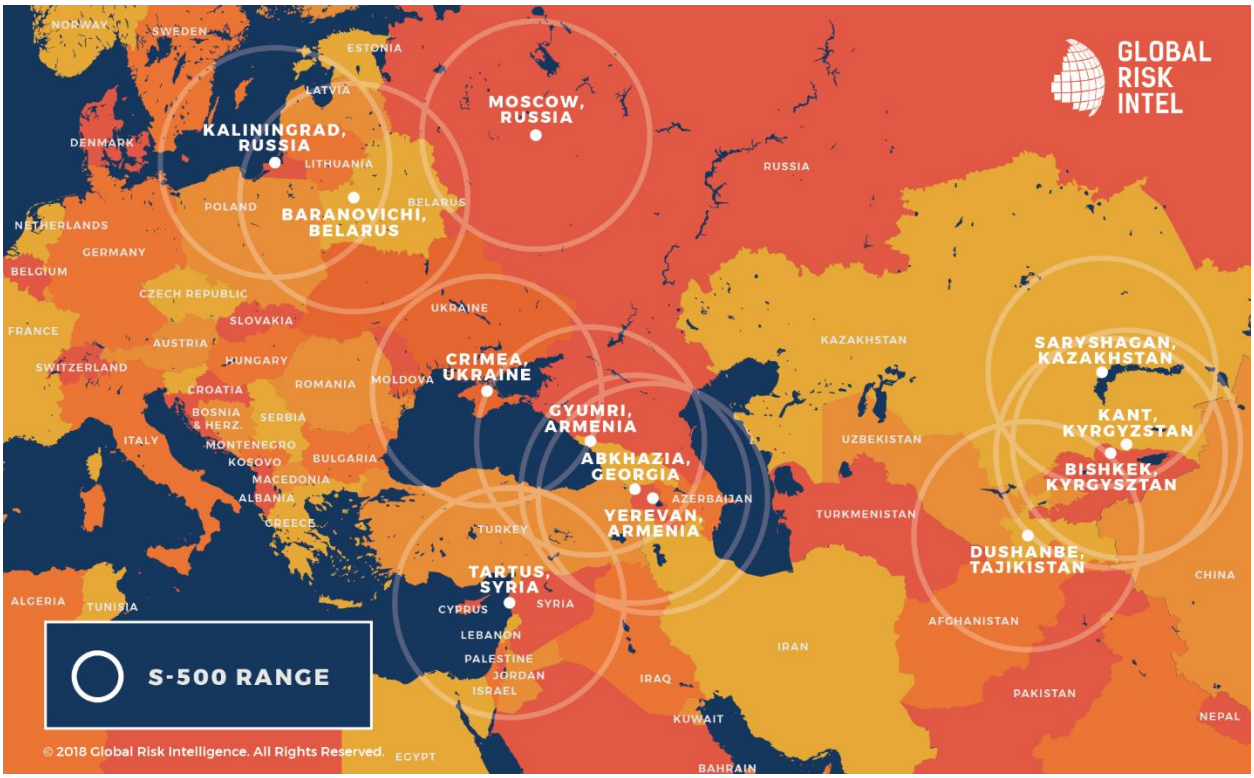

Figure 7: Theoretical S-500 missile system placements and associated range potentials spanning Europe and Asia.

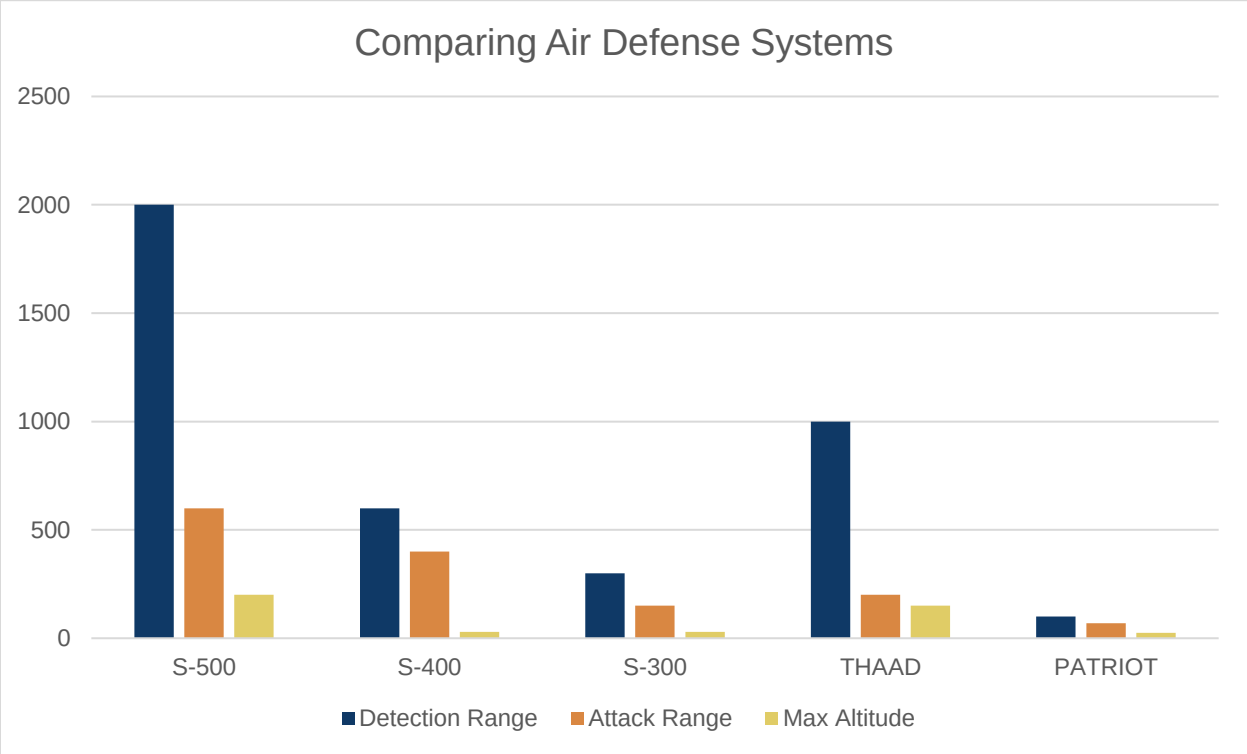

Figure 8: Bar graph depicting detection ranges, attack ranges, and maximum altitudes of missile systems produced by Russia (S-500, S-400, and S-300) and the United States of America (THAAD and Patriot).

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