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DEFENSE TECHNOLOGY PROGRAM BRIEF

Hypersonic Weapons

By: Margot van Loon, Dr. Larry Wortzel, and Dr. Mark B. Schneider

BRIEFING HIGHLIGHTS

Hypersonic weapons are coming online just as the United States shifts its focus back to great power competition as its most pressing national security threat. To China and Russia – both of whom are rapidly modernizing their military capabilities and seeking ways to expand the role of nuclear weapons in their strategies–the unique characteristics of hypersonic systems (including their ability to render useless all current U.S. missile defenses) represent a perfect opportunity to take the lead in a high-stakes technological field.

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Because of their speed and maneuverability, it would be nearly impossible to predict what facilities (or even what country) is being targeted if a country detected the launch of one of these weapons. Moreover, it would be impossible to know for certain the type of warhead it carries, meaning that a conventional strike could easily be mistaken for a preemptive nuclear attack.

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The Russians may see destruction of the U.S. national command authority in a pre-emptive nuclear strike as a means to win a nuclear war because it could delay any U.S. decision to retaliate until after the main Russia nuclear attack arrives or even prevent a U.S. decision to retaliate or its execution.

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After booster burnout of a hypersonic boost glide vehicle or other hypersonic missiles (all types of hypersonic missiles require rocket boosters) we will lose track of it. It evades attack confirmation by U.S. early warning radars. Since we don't get radar tracking data, we don't know where the missiles will impact until they do or just seconds before.

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Hypersonic weapons are what Beijing sees as asymmetric forms of "assassin's mace weapons" have been China's weapons of choice to hold the U.S. military and its bases in Asia at risk.

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According to Michael Griffin, U.S. Undersecretary of Defense for Research and Engineering, "a space-based hypersonic defense is not a practical approach, in my way of thinking. Even if you had space-based interceptors, it would be technically the wrong way to do it. The role for satellites and space surveillance is in the indications of warning, the launch detection, the surveillance, acquisition, tracking — the whole arena of persistent global timely awareness."

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Hypersonic Weapons: A Primer

By Margot van Loon

In today's Department of Defense, one of the most crucial missions is known as "conventional prompt global strike" (CPGS). The complex title belies a simple objective: in the most basic terms, CPGS seeks to guarantee the ability to strike a target any time at any place in the world in under an hour.[1] Of the multiple capabilities being pursued to achieve this objective, hypersonic weapons are rapidly becoming one of the most vital – and the most hotly debated.

Velocity and maneuverability are the variables that transform traditional missile capabilities into this exotic new class of weapons. As the name implies, anything traveling five times faster than the speed of sound can be considered "hypersonic." From there, hypersonic capabilities fall into two general categories: cruise missiles capable of Mach 5+ speeds; and boost glide vehicles, which are launched via rocket but then can glide unpowered upon reentry into the atmosphere while maneuvering and steering, and do so for thousands of kilometers.[2]

What's the hype?

The advent of hypersonic weapons has been described as a "renaissance" in the field of missilery. Indeed, while the concepts of a supersonic weapon that could be controlled and maneuvered have been

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studied for decades, translating them into development and production has only now become feasible thanks to recent technological advances. Any country seeking to count hypersonic weapons among its military capabilities can anticipate a number of crucial advantages, all related to an increased degree of uncertainty posed by these weapons to an adversary in the event of a conflict. To start, the velocity with which hypersonic weapons would be able to reach their targets reduces the adversary's ability to either relocate or respond before the strike occurs. Meanwhile, the weapons' maneuverability allows them to travel on unpredictable trajectories, making it difficult to track and destroy them before they successfully penetrate advanced air and ballistic missile defenses.[3] Lower signatures and an ability to fly at lower altitudes also compound the challenge of finding, targeting, and intercepting hypersonic vehicles for current missile defense systems like the Ground-Based Interceptor (GBI), Terminal High Altitude Area Defense (THAAD), and Patriot.[4] The fact that these vehicles can carry either nuclear or conventional warheads adds another element of uncertainty to an already unpredictable threat. In short, hypersonic technologies are changing the game. As Dr. Mike Griffin, DoD's Under Secretary for Research and Engineering, has noted, "this is not an advantage that we can concede to people who wish to be our adversaries."[5]

*Both countries [Russia and China] have conducted **multiple tests** of these systems while continuing to funnel **massive funding** into hypersonic weapons research and development (R&D)–two trends that, in the last year, have thrust the United States' own hypersonic efforts into an uncomfortable spotlight.*

What does this mean for great power conflict?

Hypersonic weapons are coming online just as the United States shifts its focus back to great power competition as its most pressing national security threat. To China and Russia – both of whom are rapidly modernizing their military capabilities and seeking ways to expand the role of nuclear weapons in their strategies[6] – the unique characteristics of hypersonic systems (including their ability to render useless all current U.S. missile defenses) represent a perfect opportunity to take the lead in a high-stakes technological field.

Russia's "Kinzhal" aircraft-launched boost-glide vehicle is currently operational,[7] and its nuclear-capable "Avangard" system will reportedly come online in 2019 (after much rhetorical fanfare from Vladimir Putin and other high-profile Kremlin officials, who have alarmingly boasted of the role such capabilities could play in a potential decapitation strike on the United States).[8] China has tested multiple systems, including the "Starry Sky-2" boost-glide system and the DF-ZF unpowered glide vehicle (referred to by DoD as WU-14) that would give Beijing conventional prompt strike capability over a multi-thousand kilometer range.[9] Both countries have conducted multiple tests of these systems while continuing to funnel massive funding into hypersonics research and development (R&D)[10] – two trends that, in the last year, have thrust the United States' own hypersonic efforts into an uncomfortable spotlight.

Somewhat understandably, the pace of testing and the adversarial rhetoric has contributed to perceptions and fears among American policymakers of a new arms race. However, the reality may be more tempered. James Acton, co-director of the Carnegie Endowment for International Peace, has argued that "in many ways, the United States is running a different race from Russia and China."[11] Russia and China are generally believed to take a different view of the role that hypersonic weapons can play in their strategy than the United States. Their interest appears vested in the capability of getting nuclear-armed vehicles past U.S. ballistic missile defenses. To many U.S. experts and leaders, this is not the strategic disruption it might seem. They assert that intercontinental ballistic missiles and submarine-launched ballistic missiles already give Washington, Moscow, and Beijing an unpreventable ability to launch a nuclear strike. Adding nuclear-equipped long-range hypersonic weapons that can defeat current missile defenses essentially results in the same outcome, and thus would not truly alter the strategic balance among the three powers that currently possess them.[12] Rather, U.S. officials see greater potential value in the ability of conventionally-armed hypersonic weapons to disrupt the tactical dynamics of regional or theater conflicts by expanding U.S. response options without crossing the nuclear threshold.[13]

Certainly, hypersonic threats do not necessarily require hypersonic responses, and the logic of deterrence still matters.[14] Should Beijing or Moscow field hypersonic weapons with conventional warheads,

however, this would allow them "to threaten, with non-nuclear warheads, targets in Europe and eventually the continental United States that, previously, [they] could only have destroyed with nuclear weapons," [15] rendering U.S. missile defenses obsolete while holding the United States at risk and lowering the bar to full-blown military conflict.[16]

That said, the inadvertent escalation risk of hypersonic weapons should not be underestimated. Because of their speed and maneuverability, it would be nearly impossible to predict what facilities (or even what country) is being targeted if a country detected the launch of one of these weapons. Moreover, it would be impossible to know for certain the type of warhead it carries, meaning that a conventional strike could easily be mistaken for a preemptive nuclear attack.[17]

What is the state of current U.S. efforts and countermeasures?

DoD recognizes the important offensive role that hypersonic weapons will play in power projection, deterrence, and reassurance, particularly in the face of the advanced anti-access/area denial (A2AD) strategies of Russia and China. Indeed, recent budgetary trends reflect a dramatic shift in the willingness of both the legislative and executive branch to begin recognizing the importance of hypersonic programs. The Department plans to spend $10 billion in the next five years on the development of both offensive and defensive hypersonic capabilities, and the 2019 budget request for hypersonic weapons research funds increased 136% over the previous year.[18] Under Secretary Griffin, who has played a significant role in moving the needle on this issue, has promised that the next few years will be a time of rapid maturation for U.S. hypersonic programs: "you're going to see our testing pace stepping up, and you're going to see capability delivery from the early '20s right through the decade."[19]

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In this context, U.S. efforts on offensive capabilities are making reasonable progress. General John E. Hyten, Commander of U.S. Strategic Command, has confirmed that DoD is pursuing at least 16 different lines of effort in the development of American hypersonic capabilities while also arguing for better prioritization to get the systems fielded as quickly as possible.[20] These programs include the Advanced Hypersonic Weapon (AHW), a boost-glide vehicle with a range between 6,000 and 8,000km currently under the auspices of the Navy;[21] the joint DARPA-Air Force Tactical Boost Glide (TBG) program on rocket-propelled hypersonics; and the broad umbrella of the Hypersonic Air-Breathing Weapon Concept (HBWC) devoted to the technologies required for jet-propelled hypersonic cruise missiles. [22]

*Should China or Russia launch a strike on the United States or its allies, current missile defense capabilities would be **rendered useless.***

Of more pressing concern is the state of U.S. countermeasures. Should China or Russia launch a strike on the United States or on its allies, current missile defense capabilities would be rendered useless. Technically, current U.S. systems like Patriot or THAAD can intercept ballistic missiles, which have a faster velocity in the terminal phase of flight than a hypersonic glide vehicle. However, such systems are only effective over a limited area; the maneuverability of hypersonic vehicles demands coverage of virtually the entire continental United States – an impossible feat from both a cost and feasibility perspective.[23] Congress has since mandated that DoD create and deploy a space sensor layer,[24] which could detect and track the signature of a hypersonic vehicle after launch as it travels at lower altitudes invisible to most ground-based radar.[25] However, detection and tracking is only part of the kill chain: General Hyten drove this point home before the Senate Armed Services Committee in March 2018, warning that "we don't have any defense that could deny the employment of [hypersonic glide vehicles] against us, so our response would be our deterrent force, which would be the triad and the nuclear capabilities that we have to respond to such a threat."[26] The development of complete countermeasures to offset the hypersonic threat will likely require not only detection capabilities, but

also a hybrid approach of kinetic interceptors and other non-kinetic means as well as an entire new command and control architecture capable of processing data quickly enough to respond to and neutralize an incoming hypersonic threat – a far cry from the current reality.

What other challenges lie ahead?

Beyond the actual acquisition of hypersonic capabilities, U.S. decisionmakers must anticipate and account for three primary obstacles as they move forward with the development and fielding of these systems.

First, institutional and cultural challenges will inevitably plague the ramp-up of such an expensive and high-profile effort. While former Secretary of Defense Ash Carter appointed the Missile Defense Agency (MDA) as the executive agency for the counter-hypersonic mission, the recent addition of the Space Development Agency to the DoD bureaucracy foreshadows a battle over portfolios and budgets that is likely to play out over the long term.[27]

Related, the growing recognition of the importance of these systems has not yet fully translated into the requisite appropriation of resources. DoD's most recent budget request only contained $157 million for hypersonic missile defense,[28] leaving a number of MDA's priorities underfunded (among them the development and deployment of space sensors). By some accounts, U.S. research and development on hypersonics is only half the size of China's infrastructure.[29] Several top DoD officials have expressed fears that if this gap between intention and resources persists, the U.S. military will be playing permanent catch-up with its adversaries in this field,[30] rather than reasserting technical dominance by prioritizing this new class of technologies and systems in the same way that our adversaries have chosen to do.

Finally, the United States as well as Russia and China will have to contend with the challenge of technological proliferation. At present, only these three countries are playing in the hypersonic field, in part because of the technical challenges and expense involved in doing so. It is a difficult feat to build these weapons, since they generate a massive amount of heat (unlike a traditional ballistic missile, which only requires protection of the reentry vehicle and for only a short period of time).[31] However, this means that international export controls limiting the spread of hypersonic hardware and technologies have yet to even be discussed, let alone instituted. It is only a matter of time before other countries begin clamoring for hypersonic capabilities of their own; a recent study by the RAND Corporation suggests that there is, at best, a decade "available to substantially hinder the potential proliferation of hypersonic missiles and associated technologies."[32] The study further concludes that failure to prevent proliferation would increase the ability of other countries to threaten credible attacks and could create dangerous escalation risks.[33]

The development of complete countermeasures to offset the hypersonic threat will likely require not only detection capabilities, but also a hybrid approach of kinetic interceptors and other non-kinetic means as well as an entire new command and control architecture capable of processing data quickly enough to respond to and neutralize an incoming hypersonic threat.

Hypersonic Weapons in China's Military Strategies

By Larry M. Wortzel

China's nuclear deterrence strategy for decades depended on a small, or limited, number of nuclear weapons that could inflict heavy and unacceptable damage on an adversary if the country was attacked.[1] However, despite claims of a limited deterrent, the number of Chinese nuclear capable missiles has grown over the years, along with its stockpile of warheads.[2] As ballistic missile defenses improved and surrounding countries such as India developed nuclear weapons, the Chinese People's Liberation Army began to develop other technologies and systems to ensure it could maintain its deterrence posture. Among the approaches to secure a deterrent capability China has taken are developing a nuclear ballistic missile submarine force, developing new types of mobile ballistic missile systems with multiple warheads and penetration aids, and developing

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hypersonic warheads and missiles.[3] Today, aspects of that strategy are changing as China develops hypersonic warheads for ballistic missiles and hypersonic cruise missiles.

The People's Liberation Army believes that "hypersonic technology is the commanding height of aerospace technology."[4] Li Jun, a PLA writer, argues that the combination of supersonic speed, a high likelihood of battle damage, the capability to penetrate armor with conventional warheads, and a high capacity to penetrate defenses for the PLA means that cruise missiles and ballistic missile warheads can attack reinforced targets and improve on subsonic kinetic warheads.[5] Li Jun sees Russia as the leader in hypersonic technologies, but notes that the United States is not far behind. He notes that "a "U.S. Tomahawk cruise missile takes more than an hour to strike a target 1000 kilometers away … while a hypersonic weapon can fly more than 1,000 kilometers in eight minutes.[6] This study will focus on China's development of hypersonic weapons and the implications of those weapons for the United States.

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According to the Defense Intelligence Agency's *2019 China Military Power Report*, "the PLA is developing a range of technologies to counter U.S. and other countries' ballistic missile defense systems, including maneuverable reentry vehicles (MARVs), MIRVs, decoys, chaff, jamming, thermal shielding, and hypersonic glide vehicles.[7] The DIA report goes on to discuss other areas where China is concentrating significant R&D resources including nuclear fusion and the deployment and "hardening" of an expanding constellation of multipurpose satellites. Some of these space and satellite developments are designed to assist in targeting for these hypersonic weapons.

China's Quest for Deterrence and Sea Denial

By itself, the deployment of missile defenses by the United States and its allies in Japan and South Korea does not explain the entire rationale for the focus on hypersonic weapons in China. Rather, part of the PLA's urgency is driven by a particularly embarrassing set of circumstances that developed around China's own missile threats against Taiwan.[8]

In 1995 and 1996, in an effort to influence the presidential election in Taiwan, the PLA launched "a major psychological warfare operation that, at the same time, was a display of military force and a warning to Taiwan not to go too far in moves toward democracy and independence."[9] The PLA conducted a series of military exercises that simulated an invasion of Taiwan and also announced impact zones at sea, and closed areas for air traffic, in the vicinity of the Taiwan Strait. The closure areas for the missile tests, which bracketed Taiwan, "had the effect of a temporary blockade or embargo of shipping and air travel to Taiwan."[10]

In response to China's missile exercises and actions, which began on March 8, 1996, President Bill Clinton announced that two U.S. aircraft carrier battle groups would be dispatched into the area. Ultimately, the carrier battle groups stayed out of the Taiwan Strait, but were deployed within striking distance of China and Taiwan. The carriers stayed in the area throughout the PLA exercises, which ended after Taiwan's presidential election on March 25, 1996.[11] Evidence suggests strongly that these events led to the development of new missiles systems in China that were designed to attack U.S. carriers at sea, and which were the precursor of China's focus on hypersonic glide vehicles.

*The **deployment of missile defenses** by the United States and its allies in Japan and South Korea, alone, does not explain the entire rationale in China for the **focus on hypersonic weapons.** Part of the PLA's urgency is driven by a particularly embarrassing set of circumstances that developed around China's **own threats against Taiwan with missiles**.*

At that time, the author was the U.S. Army attaché assigned to the American Embassy in Beijing. At an evening reception at a foreign embassy, he began a conversation with a senior PLA general, a member of China's Central Military Commission. After a cordial greeting, the general said that the U.S. had gone too far and China would not be humiliated again. He threatened that, in the future, China would develop missiles that could attack U.S. carriers. Thus, while the PLA may not

have been working on the architecture of space, surface surveillance and missiles needed to attack a carrier at that time, what developed into China's counter-intervention doctrine, or anti-access/area denial doctrine,[12] as the U.S. calls it, probably had its genesis in those events.[13]

China's approach to protecting itself from potential attack by the U.S. and further humiliation now involves not only ballistic missiles; it includes ships and aircraft equipped with cruise missiles, many of which will be hypersonic or carrying maneuvering hypersonic missile warheads. These missiles and warheads travel at five times the speed of sound and are "especially challenging for U.S. defenses" because they either evade U.S. radar and sensor architectures or move so fast the U.S. cannot defend against them without a new generation of systems.[14]

We also must keep in mind that one lesson of the 1996 U.S. carrier battle group deployment for China was that the PLA needed ways to keep U.S. forces at risk further away from China's shores. The PLA's area control and counter-intervention strategy focuses on degrading an opponent's technical and weapons advantages and controlling the maritime approaches to China – or, at a minimum, denying the enemy full freedom of action in the maritime approaches to China.[15] The initial effort by the PLA to use missiles for this purpose was the development of a suite of electronic warfare and reconnaissance assets, means to neutralize an enemy's missile sensor and anti-missile systems, and means to interfere with the C4ISR[16] systems of any enemy. To do this, the PLA made strong advances in naval force deployments, developed new air force assets, and from a strategy standpoint sought to employ "soft" attacks with electromagnetic energy systems and "hard" attacks that follow up on "soft strikes" such as cyber- attacks or the use of electro-magnetic pulse weapons with precision strike kinetic attacks.[17]

Focusing on missiles and the threat to "attack an American aircraft carrier with missiles," the first phase was the modification of the PLA's *Dong Feng* 东风 *21*. The *DF-21*, as it is known, is a single stage, road mobile, solid fueled medium-range ballistic missile. The missile has been in service since about 1991 and has several variants. The *DF-21* can carry both conventional and nuclear warheads and has a range of about 900-1000 miles.[18] The anti-ship ballistic missile (ASBM) variant *Dong Feng 21D* is called the "carrier killer" and was developed with the specific intent of attacking large ships, like an aircraft carrier, at extended ranges from China.[19] Ajai Shukla, a military analyst in India, also noted that at the 2018 Zhuhai Air Show the China Academy of Launch Vehicle Technology (CALVT) offered the *M-20B* ASBM on the international market. This is an export version of the *DF-21D* ASBM, with its range limited to 280 kilometers so that the sale adheres to the Missile Technology Control Regime (MTCR). [20] The longer range *Dong-Feng-26,* discussed below, also is nuclear capable.

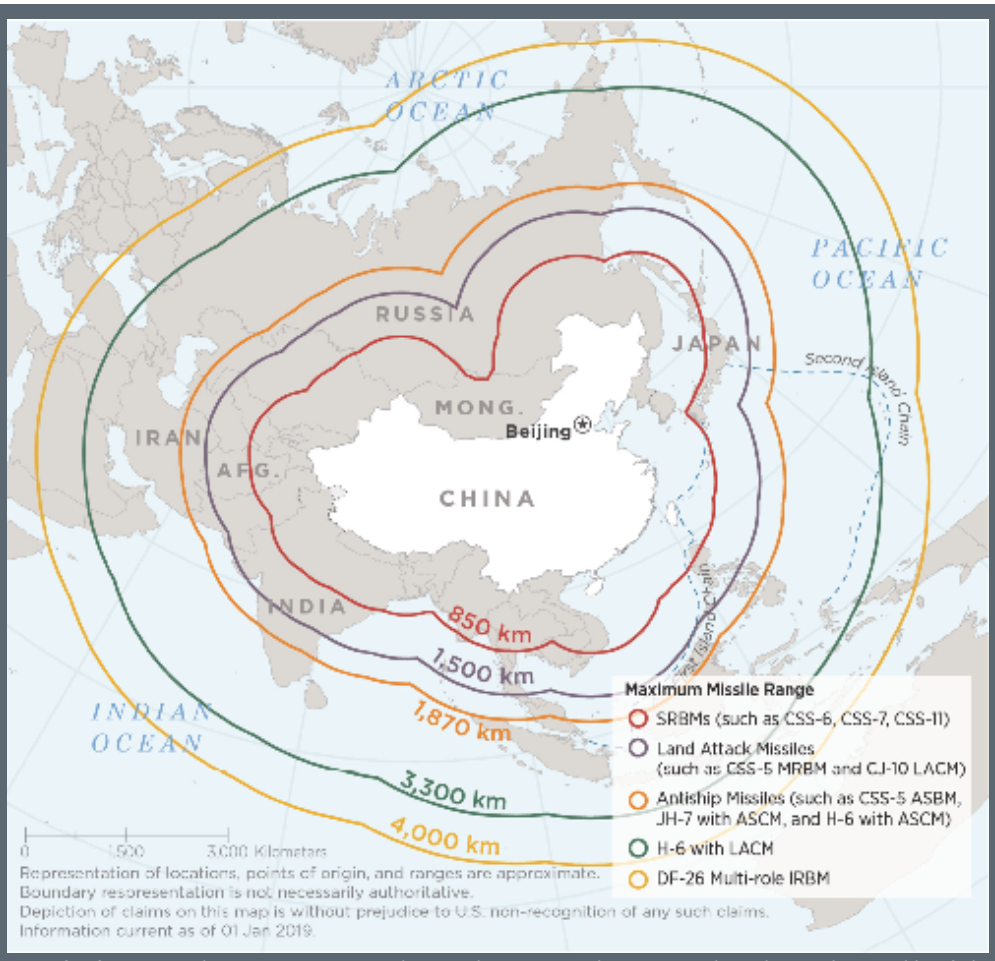
Shukla's fears are somewhat overstated, however. To be able to use the ASBM against naval formations or ships, Pakistan would need a complex intelligence, surveillance and reconnaissance system involving satellites and long-range, over the horizon radar. Still, if the PRC put different seekers on the warhead, at these shorter ranges, a target could be painted with a laser or other surface radars might work.

The *DF-21D* warhead was designed to use terminal guidance to modify its trajectory during warhead reentry. Articles in China's *Aerospace Electronic Warfare* and *Command, Control and Simulation* military journals theorize that once in a terminal mode a DF-21D warhead will have about one hundred kilometers (about 60 miles) of maneuvering ability guided by the warhead's terminal seeker.[21] PLA researchers believe that a carrier "cannot effectively escape an attack within a short period of time."[22]

The range of a U.S. *Tomahawk* cruise missile is probably a little longer than that of the *DF-21D*; but the U.S. Navy's F/A-18E/F *Super Hornet* fleet has a range of just over 500 miles when loaded with munitions.[23] This is not far enough to attack any ant-ship ballistic missile launchers or batteries. Two responses by the U.S. Navy are to extend the range of the F/A-18, and to explore the use of unmanned aerial vehicles to refuel the aircraft, thus extending the range.[24]

As the United States adjusted its tactics, the PRC began to develop additional missile capabilities to accomplish its counter-intervention mission. The U.S. Navy refused to allow the PRC to conceptually prevent it from conducting operations inside the second island chain, extending roughly from the mainland of Japan through Guam and the Marianna islands.

One response to China's sea denial operations with the *DF-21D*, anti-ship cruise missiles, and submarine operations was to develop a concept of "distributed lethality" for naval forces.[25] The idea behind the concept was that instead of concentrating on self-



Source: Office of the Secretary of Defense, Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2019 (Washington, DC: Department of Defense, 2019), p. 45. https://media.defense.gov/2019/May/02/2002127082/-1/-1/1/2019_CHINA_MILITARY_POWER_REPORT.pdf

defense and defense of the carrier strike group, the Navy will "add another dimension to U.S. capability" by creating a surface force that has the capacity to conduct offensive operations across the maritime battlespace.[26] Navy strategists developed the concept of distributed maritime operations, "where the Marine Corps and Navy are preparing for a high-end fight that will require ships to be distributed across the ocean rather than clustered around an aircraft carrier."[27]

The U.S. Air Force already had been discussing more seriously forms of expeditionary operations and rapid deployments of air power into the Pacific region.[28] The Marine Corps also had begun to experiment with distributed operations and concepts applied in the Middle East looked like they would also be effective in Asia.[29] And the U.S. began to build up air and naval forces in Guam, an area that the PLA's *DF-21D* could not reach. Hence, the PLA began to develop a new missile, the *DF-26*, that can bring Guam and the Tinian Islands within strike range using nuclear warheads or conventional hypersonic warheads.

That race for a strike capability against U.S. deployed forces in China was carried on while PLA strategists explored other forms of operations. In particular, a senior researcher at the Chinese Academy of Military Science, Jiang Yamin, published a book that discussed what he believed to be serious deficiencies in PLA capabilities that leave China's mainland and populace open to attacks by a "hegemonic," advanced military power.[30] Jiang argued that the PLA needs to be able to engage enemies with long distance and expeditionary operations at far distances from China's immediate shores and waters, as well as be able to threaten an enemy's civilian populace in the same ways that he believes China's populace is threatened.[31] This book foreshadowed current PLA training and high-technology capabilities that have led to the development of hypersonic weapons and a range of information operations and electronic warfare concepts.[32]

It is clear that there is a competition going on between the United States and China for the ability to conduct military operations in the Western Pacific. China has a number of concerns here:

- U.S. Freedom of Navigation Operations in areas of international waters that China claims as its own;
- China's fears that the U.S. might intervene in any attempt by the PRC to take Taiwan by force, blockade the island or conduct missile or artillery strikes on the island;
- U.S. support for Japan as a treaty ally should China enter into conflict with Japan over the Senkaku Islands in the East China Sea;
- U.S. commitments to the Republic of Philippines, another U.S. treaty ally with which China has disputes over a number of South China Sea islands; and
- A concern that the U.S. may challenge China's claims of sovereignty over the entire South China Sea and East China Sea.

Hypersonic weapons, what Beijing sees as asymmetric forms of "assassin's mace weapons," have been China's weapons of choice to hold the U.S. military and its bases in Asia at risk. These are not China's only measures. Beijing has developed what it calls "integrated network electronic warfare or INEW" which involves jamming, cyber penetrations, space and anti-satellite warfare, precision strikes, and computer network attack as one way to counter U.S. military operations.[33] Also, Beijing is developing a range of directed energy weapons such as high power microwave, high energy lasers, and rail guns as a means to address what the PLA sees as U.S. military advantages.[34] Although the PLA's INEW capabilities are well developed, its pursuit of directed energy weapons is not moving along as quickly as Beijing might want. Scale of weapons, physics challenges, and an adequate power supply are slowing the development of these systems for the PLA, just as they are for the U.S. military. It is in its development and fielding of hypersonic weapons where China is surging forward more quickly than the United States.

Beijing is developing a range of directed energy weapons such as high power microwave, high energy lasers, and rail guns as a means to address what the PLA sees as U.S. military advantages.

The Missiles and Warheads

In August 2018, the *Washington Free Beacon* reported that China had conducted a flight test of a new hypersonic missile that is nuclear capable. The Xingkong-2 or Starry Sky-2 missile is multi-stage and capable of maneuvers at speeds of Mach 5.5, with a top speed of Mach 6 (4,603 miles per hour).[35] Six months prior to that, the *Free Beacon* carried an article reporting the testing of a hypersonic Glide Vehicle (HGV), the *DF-ZF,* also known as the WU-14.[36] This missile warhead glides near its target in near space and can maneuver during reentry, confounding any U.S. defenses. The WU-14 is capable of maneuvering at speeds of between Mach 5 and Mach 10, or between 3,836 and 7,672 miles per hour. China's test of the WU-14 came after the U.S. tested its own hypersonic missile design from an *Ohio*-class submarine, an indication that deterrence by demonstrating a similar capability is one factor driving PLA testing.[37]

On January 27, 2019, the PLA tested its *Dongfeng-26* ballistic missile, which not only brings Guam into range but also is capable of targeting enemy naval formations at greater distances from China's shores than the *DF-21D*.[38] The *DF-26* is mentioned earlier in this paper as the "Guam Killer." Publicity surrounding the test in one of China's Communist party-controlled newspapers revealed that this was the test of a nuclear or conventional strike/anti-ship missile using a hypersonic gliding warhead.[39] The article also claims this is the world's first supersonic mid-range and long-range missile with boost-gliding technology.

At the 2018 Zhuhai Air Show, the PRC showed off a model of the *CM-401* anti-ship cruise missile (ASCM), manufactured by China Aerospace Science and Industry Corporation (CASIC).[40] The CASIC brochure, according to media coverage from India, described the *CM-401* as world's first "ultrafast ASBM." The brochure's claim may not be truthful, however; Russia developed a hypersonic ASCM much earlier. The Russian *BrahMos II* hypersonic missile system was first tested in 2011 and is known in Russia as the *3K22*.[41] The *BrahMos II* has been sold to India. A newer Russian hypersonic ASCM, the *Zircon,* may be a domestic version of the *BrahMos II*. Nevertheless, despite the fact that the *CM-401* may not be the first hypersonic ASCM, its development represents a major achievement for China and a significant threat to U.S. warships.[42]

The Threat

Michael Griffin, the U.S. Undersecretary of Defense for Research and Engineering, told reporters in July

2018 that it would be a mistake to cede the ground in the competition to develop hypersonic weapons to U.S. adversaries.[43] According to Griffin, hypersonic missiles require a "very quick response;" their high speed and high maneuverability make them difficult to find and difficult to kill."[44] Griffin's view is that "a space-based hypersonic defense is not a practical approach in my way of thinking. Even if you had space-based interceptors, it would be technically the wrong way to do it."[45] The role for satellites and space surveillance is in the indications of warning, the launch detection, the surveillance, acquisition, tracking — "the whole arena of persistent global timely awareness," according to Griffin.[46]

Sensors in space and surveillance from space are also of great utility to China in targeting these missiles. China has arrays of space sensors that will work with over-the horizon radars and other air or ship based sensors to find targets for ASCMs and hypersonic glide vehicles. Therefore, any conflict in which hypersonic weapons come into play will likely spread to space.

China's test of the WU-14 came after the U.S. tested its own hypersonic missile design from an Ohio-class submarine, an indication that ***deterrence by demonstrating a similar capability*** *is one factor driving PLA testing.*

The U.S. response of dispersed naval formations is one defensive measure, but the speed and accuracy of hypersonic warheads threaten new U.S. concepts for military operations in the Pacific, namely the U.S. Marine Corp's Expeditionary Amphibious Base Operations (EABO), the U.S. Army's concept of a Multi-Domain Task Force (MDTF), and the U.S. Air Force concept for the distribution of forces throughout a theater of operations.[47] The threat pose by these hypersonic warheads means that a combination of passive defensive measures like high mobility, deception, electromagnetic signature reduction or emissions control, and camouflage can all help protect a deployed unit. Additionally, active measures like jamming and other electronic countermeasures have great application.

Among the technologies that can address the hypersonic threat are high power microwave weapons, particle beam weapons, and laser weapons. Combined with forms of cooperative target engagement, adequate defenses are possible. However, these systems are only in the development phase at this time. In the future, when the weapons systems are developed, combining them with artificial intelligence and new fire control systems potentially offers better defenses. However, the sheer amount of electrical power needed for these weapons means that land-based and ship-based systems will probably be available before airborne systems.

Conclusions

According to *The Economist,* the U.S. has "set aside $2.6bn for hypersonic weapons in the Pentagon's 2020 budget," and is probably farthest ahead in its development of hypersonic capabilities.[48] The *Economist* notes that the U.S." tested a wedge-shaped glider in 2010 and 2011, a more successful cone-shaped design in 2011, 2014 and 2017." The U.S. is also working on systems that could be air and ship-launched.[49] China, however, has tested the *DF-ZF* hypersonic glide vehicle "at least nine times since 2014,"[50] and may therefore be closer to fielding these systems than the United States. Moreover, China's anti-ship cruise missile, the *CM-401*, is already in production. This means that deployed U.S. forces at sea and engaged in the defense of island chains already face threats from hypersonic weapons.

Despite what may be a current U.S. lead in research and testing, China already possesses hypersonic anti-ship cruise missiles.[51] Also, China has a robust inventory of ballistic missiles, many of which can be quickly adapted to use hypersonic warheads. Like the U.S., the PRC also has a well-developed space surveillance system and over-the-horizon radar systems that will support the use of hypersonic glide vehicles. For the U.S., developing long-range cruise missiles for surface attack and stealth long-range strike UAVs would improve force capability in the future.[52]

All of this means that Congress should be aware of the threat from China (and other countries), gauge its authorizations and appropriations accordingly, and – along with the Department of Defense – prioritize development of both defenses and hypersonic systems consonant with the priority given to Asia and the Indo-Pacific region in U.S. strategy. Meanwhile, as they develop force packages and operational strategies for the Indo-Pacific region, the services must ensure that defenses and tactics are adequate to meet the serious threat that is posed by China's hypersonic weapons, both today and in the future.

Moscow's Development of Hypersonic Missiles… and What It Means

By Dr. Mark B. Schneider

The Russian Federation has achieved a monopoly in hypersonic missiles in its confrontation with the U.S. and NATO. While hypersonic missiles are hard to build, the Russian programs are real, notwithstanding Russian hyperbole. According to STRATCOM Commander General John Hyten, "…you should believe Vladimir Putin about everything he said he's working on."[1] President Putin has said Russia has one operational hypersonic missile with a range of over 2,000-km, and a second with intercontinental range that will be operational this year.[2] Thus, the Russian monopoly will last at least until 2020 – even assuming a highly successful test program for the U.S. Air Force's conventional hypersonic weapon, which is quite optimistic.[3] In other words, the Russian monopoly on intercontinental-range hypersonic missiles will last for the foreseeable future. Moreover, Russia will have a permanent monopoly on nuclear hypersonic missiles unless there is a major change in U.S. policy. Here ideology, not technology, has been the limiting factor for the U.S.

The Russian advantage in hypersonic missiles is not a result of superior Russian technology. Russian technology is clearly inferior to our own in many areas. Rather, the Russian advantage mainly results from the fact that the Kremlin has been preparing for a war with the United States for decades, while we, at least until the 2014 Russian invasion of Ukraine, were in denial about so-called "near peer competitor" threats. And as a practical matter, the U.S. invested little in hypersonic weapons research until the advent of the Trump administration – at which point, we began to play catchup. The Pentagon's FY 2020 budget request includes $2.6 billion for hypersonic weapons development.[4] Yet even today, U.S. efforts to catch up to Russian advances are only partial in nature, because they do not involve nuclear capable missiles. In light of Russian views concerning the importance of nuclear capabilities and hypersonic missiles, this is a dangerous decision.

In March 2019, Russian Prime Minister Dmitry Medvedev stated, "Our hypersonic missiles are of high precision and reliability."[5] President Vladimir Putin compared the *Avangard* hypersonic boost glide missile to "the launching of the world's first artificial satellite."[6] This is debatable, but the real question is whether Putin actually believes this. He probably does. He may even exaggerate the military significance of this and other systems in his own mind, which could impact his future decisions and may lead to war and nuclear escalation.

Hypersonic weapons have now been incorporated into two of Russia's standard nuclear weapons threats – the nuclear superweapons threat and the nuclear missile targeting threat.[7] Russia sees nuclear threats as a means to enhance its power, and uses them frequently. These threats are deployed any time something happens in world affairs that Russia does not like. There have been many such threats since the U.S. announced the suspension of the INF Treaty earlier this year in response to very serious Russian violations of the Treaty. Notably, these threats have included reference to hypersonic weapons. According to Russian Deputy Foreign Minister Sergei Ryabkov:

> There are hypersonic warheads, different types of air and underwater autonomous systems, the new heavy missile, which is being developed. Successful test-launches of the Avangard and Kinzhal systems were recently conducted. All this and much more makes up the set of forces and means that reliably neutralize any potential threat on the part of the U.S. and any other direction wherever they come from.[8]

The incorporation of hypersonic weapons into the usual Russian nuclear threat reflects Moscow's perception of the significance of its current monopoly on hypersonic weapons.

In his February 2019 State of the Nation address to the Duma, President Putin promoted the *Tsirkon* (Zircon) hypersonic missile into the superweapon category, hinting that it would be used to launch surprise strikes against the U.S. national command authority.[9] Within days, a retired Russian Admiral said that the *Tsirkon* would be capable of hitting command posts in

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the U.S. within five minutes from Russian submarines and, "Russia's Vesti Nedeli state TV station published a list of American targets it said the Kremlin could strike with hypersonic nuclear missiles within five minutes if war breaks out."[10] In an important March 2019 speech, the Chief of the Russian General Staff, General Valery Gerasimov, said Russia was forced to "plan future delivery of strikes against decision making centers…"[11] This constitutes a very serious threat, both because Washington is undefended against hypersonic missiles and because of the lack of deep underground bunkers in Washington to protect the national command authority from a surprise nuclear attack.

Chief of the Russian General Staff General of the Army Valery Gerasimov said Russia was forced to "plan future delivery of strikes against decision making centers…" This is a very serious threat because ***Washington is undefended*** *against hypersonic missiles and because of the lack of deep underground bunkers in Washington to protect the national command authority from a surprise nuclear attack.*

Russia's hypersonic programs are not a response to U.S. suspension and withdrawal from the INF Treaty, as Kremlin officials contend. To the contrary, the hypersonic weapons that the Russians now brandish are the products of programs that have been going on for many, many years. Most appear to be part of the initiative that President Putin announced in his now-infamous March 1, 2018 Duma address, in which he emphasized the need for military modernization as a metric of national greatness.[12] The rest appear to be covert programs that would have violated the INF Treaty but that are now being made public so they can be used as threats. The Kremlin's announced date of 2020 for fielding an initial operating capability (IOC) for its intermediate-range and short-range ground-launched hypersonic missiles[13] is obviously impossible to achieve unless these programs have been underway for a long time.

Russian's Hypersonic Missiles

The day after the U.S. announced that it was suspending its obligations under the INF Treaty, Russian Defense Minister Sergei Shoigu told President Putin that "…we propose launching research and development, followed by development and engineering to create land-based launchers for hypersonic "intermediate-range and shorter range missiles."[14] His statement was a public confirmation of an effort that has long been underway. Yet the true state of Russia's hypersonics capabilities remains shrouded in opacity – with numerous stated promises of advanced systems (such as that of a new ground-launched version of the *Kinzhal*) that appear speculative at best.[15] But while current Russian information warfare statements about new readily available ground- launched hypersonic missiles must be looked at carefully, there are clearly multiple real hypersonic weapons programs, some of which go back as far as fifteen years or more,[16] that are now operational or approaching operational status.

The Kh-32

The Russian Kh-32 air-launched cruise missile operates at just below hypersonic speed, is dual capable (it can be equipped with both nuclear and conventional warheads) and functions as an anti-ship and land-attack cruise missile which, according to Russian state media, has a range of 1,000-km.[17] State-run *Sputnik News* states its speed as March 4.1, and *TASS*, the main official Russian news agency, claims its speed to be over Mach 5.[18] Mach 5 appears too high, except perhaps in a terminal dive, but even at a Mach 4 cruise speed, reportedly at 130,000 feet, the Kh-32 is a very serious threat, clearly very difficult and/or impossible to intercept with existing U.S. air defenses. *Sputnik News* has stated the Kh-32 became operational in 2016, and would be carried by Russian Backfire bombers.[19]

The Russian Backfire bomber, meanwhile, has been given air-to-air refueling capabilities and is being substantially modernized into the Tu-22M3M configuration. This will see improvements in almost every domain except stealth,[20] including substantially longer range even without air-to-air refueling.[21] The range of the Kh-32 is about twice that of the Cold War-era Kh-22, which in turn increases the strike radius of the Backfire and will make it very difficult to create a barrier defense using long-range fighter aircraft to protect carrier battle groups before the Backfire can get into launch range.[22]

The Iskander-M

The *Iskander-M* has been, until recently, the posterchild of Russian nuclear missiles. It is still discussed

quite a bit, although the Russians increasingly brag about their newer and more capable missiles.

According to Russia, the *Iskander-M* is a nuclear capable "aeroballistic" missile with a range of 500-km. However, there are many reports that it really has a range of up to 1,000-km when ground-launched.[23] Lithuanian Foreign Minister Linas Linkevicius has said that the *Iskander-M* has a range of 435 miles (700-km).[24] Like almost all ballistic missiles, the *Iskander-M* has hypersonic speed. Its deployment program into Russian brigade units will be completed by 2019,[25] but the capability of the Russian system will continue to be increased by other means.

Russia puts great emphasis on the ability of the *Iskander-M* to maneuver in the atmosphere, hence the terminology "aeroballistic" missile. *Izvestia* states that the missile's trajectory in the terminal phase is quite complex: "Due to the energy obtained, the rocket can perform complex manoeuvres."[26] This suggests that the missile would be very difficult to intercept in its terminal phase, but no different than ordinary ballistic missiles of that range while above the atmosphere. However, in another report, *Izvestia* stated that *Iskander-M* missiles "do not leave the Earth's atmosphere during launch…"[27] This feature would enhance its defense penetration capability, as compared to terminal-only maneuverability. Since ballistic missile defense capabilities are in short supply within NATO as a whole, even if the *Iskander-M* was an ordinary ballistic missile it would pose a serious threat to Alliance forces in its present numbers.

Russia currently has ten brigades of *Iskander-M* missiles, and a total of 120 launchers – each of which is capable of carrying two *Iskander-M* missiles and is relocatable.[28] The field reloadable capability of the *Iskander-M* launcher is very important, because it indicates that the number of missiles available to Russian generals is likely to be much larger than the number of launchers itself. Each reload vehicle of the *Iskander-M* system carries two missiles and, hence, can reload an *Iskander-M* launcher.[29]

In February 2018, Russia announced the development of an improved version of the *Iskander-M* and that the inventory of these missiles would be increased.[30] This may have been underway for years, since Russia had already announced the development of an advanced version of the *Iskander-M* back in December 2015.[31] What is clear is that Russia is attempting to intimidate the West with talk of advanced ground-launched INF range hypersonic superweapons. Whether the program is new or dates back to 2015 or even earlier, there will certainly be a quantitative and qualitative increase in the *Iskander-M* threat in the future – something which may very well include a significant increase in its range. And currently, no Western state has a missile like the *Iskander-M*.

The Kinzhal Hypersonic Missile (Kh-47M2)

The *Kinzhal* is one of the five nuclear "superweapons" which President Putin unveiled in his March 1, 2018 State of the Nation address. On that occasion, Putin called the *Kinzhal* a "hypersonic missile."[32] Actually, however, it is an "aeroballistic missile" with hypersonic speed, according to the head of the Russian Aerospace Force (the new name for the Russian Air Force).[33]

The Kinzhal appears to be an adoption of the short-range *Iskander-M*.[34] (The extra range of the air-launched version is imparted by the speed and altitude of the carrier aircraft). The range of the *Kinzhal* is more than twice the reported range of the Kh-32. President Putin has said the *Kinzhal* was capable of Mach 10, and was "the only one of its kind in the world."[35] The Russian Defense Ministry has characterized the missile as being highly maneuverable,[36] (which means it has to operate in the atmosphere for a substantial period of time rather than flying a ballistic trajectory), as well as stealthy.[37] Mere terminal maneuverability is unlikely because most U.S. theater missile defense systems cannot intercept in the terminal portion of the flight trajectory. If the *Kinzhal* flies in the atmosphere, it will have substantially greater penetration capability against theater missile defenses than would an ordinary ballistic missile with terminal maneuverability. The increased range of the *Kinzhal* makes it virtually impossible to create a barrier defense against the bombers that carry the missile.[38]

In May 2018, Deputy Russian Defense Minister Yuri Borisov said that ten Mig-31s are operational with *Kinzhals*.[39] In late 2017, *TASS*, the main official Russian news agency, reported that an "aeroballistic missile", apparently the *Kinzhal*, would be carried by the Su-34 long-range strike fighter.[40] Because the Su-34 is slower than the Mig-31, the *Kinzhal* won't fly as far when launched by a Mig-31, but the range would still be quite considerable. The Mig-41, the successor to the Mig-31, will reportedly be able to fly at 4,500-km per hour.[41] If the *Kinzhal*, or its successor, is deployed on a Mig-41, presumably it will fly significantly further than its 2,000-km+ range when launched by the Mig-31. It has also

been reported that the *Kinzhal* will be deployed on the Backfire.[42] State-run *Sputnik News* says that the aircraft can carry four *Kinzhal* missiles.[43] The Backfire, equipped with either the Kh-32 or the *Kinzhal*, would be able to target all of Europe and U.S. Navy carrier strike groups much more effectively than with legacy Soviet missiles, and can attack the continental U.S. with either long-range land-attack missiles and/or air-to-air refueling.[44]

Like the Su-34, the Backfire is slower than the Mig-31. However, the Backfire has a much longer range than either the Su-34 or the Mig-31. The improved version of the Backfire (Tu-223M3M), according to noted aviation journalist Alexander Mladenov, has a range of "5,000 nautical miles (10,000-km)…"[45] If true, this would make it an undeclared heavy bomber and, hence, a violation of the New START Treaty.

In a December 2018 speech, Defense Minister Sergei Shoigu revealed that the *Kinzhal* "has made 89 patrol sorties over the waters of the Black and Caspian seas."[46] Thus, he is apparently saying that Russian aircraft routinely "patrol" carrying nuclear capable hypersonic missiles.

The *Kinzhal* is apparently not limited by the New START Treaty, and can legally be deployed on any aircraft big enough to carry it outside of Treaty constraints. Its range will depend on the altitude and speed to which it can be carried before launch. No Western country currently has such a nuclear capable missile system. The only Western fighter-launched nuclear missile is the supersonic medium-range French ASMP-A, which has both a strategic and tactical mission.

Smaller Version of the Kinzhal

In December 2018, *TASS* reported that, according to a source in Russian industry "Russia's fifth-generation jet fighter Su-57 will be equipped with hypersonic missiles with characteristics similar to that of the Kinzhal missile…"[47] The article provided no information concerning the range of this version of the *Kinzhal*. Like the original version, this missile can presumably carry both nuclear and conventional warheads – although to a shorter range.

The Su-57, meanwhile, is quite fast, with a reported top speed of Mach 2.[48] The Mig-31, by comparison, has a reported top speed of Mach 2.35.[49] This feature, combined with its smaller size as compared to the *Kinzhal*, will certainly give the missile less range and velocity than one launched from a Mig-31.

Right now, however, Russia has planned the acquisition of only 15 operational aircraft of the initial version of the Su-57, with deployment to the troops starting in 2019.[50] At this time, we do not know how many of the improved version will be produced.

The Tsirkon (Zircon) Hypersonic Cruise Missile

The *Tsirkon* is a powered hypersonic missile with multiple basing modes. It is likely to be the cheapest (and, hence, most widely deployed) of the current Russian programs to develop and deploy hypersonic missiles. The 2017 DIA report on Russian military power predicted an 2018 IOC for the *Tsirkon*.[51] In February 2019, Duma Defense Committee head Vladimir Shamanov said that the *Tsirkon* would be put into service in the next few years.[52] The missile is now reportedly going to be deployed on aircraft, naval ships and ground launchers.[53] The *Tsirkon* is generally reported to have a speed of Mach 6,[54] although *TASS* has cited its speed as Mach 8.[55] *Sputnik News* reported that the Tsirkon "is designed for speeds of up to 12 times the speed of sound."[56] Putin has stated that the speed is Mach 9.[57]

The higher speeds, however, are unlikely in the near future.[58] References to them are probably associated with an improved version of the missile.[59] Indeed, when making threats, Russia tends to attribute the capabilities of an advanced version of a system to the initial version. However, in February 2019, Colonel (ret.) Nikolai Litovkin, a well-connected hardline Russian journalist, wrote, "Military sources state that this [the Kinzhal] is currently the only air missile able to fly at Mach 8."[60] That is significant, insofar as any number in the range of Mach 6 to 9 represents a considerable threat.

Until recently, the official range of the *Tsirkon* was 400-km, although Russian state media reported estimates of as much as 1,000-km.[61] A 2017 unclassified report of the Defense Intelligence Agency says the missile will eventually have a range of between 500 and 1000-km.[62] In February 2019, President Putin stated that the range of the *Tsirkon* was over 1,000-km.[63] The same month, Rear Admiral (ret.) Vsevolod Khmyrov stated that the range of the Tsirkon was at least 2,000-km.[64]

The *Tsirkon* will very likely be nuclear capable,[65] with an anti-ship and land-attack mission.[66] Since the *Tsirkon* is a powered hypersonic cruise missile, it does not slow down like hypersonic boost glide vehicles do. Its ability to penetrate defenses is enhanced by this and the fact that its speed can be changed by altering the fuel flow into the

engine. Since it is much smaller than the *Avangard*, it will also be much less detectable.

The *Tsirkon* has been tested from ground-based launchers (reportedly, a total of five tests by December 2018) and, reportedly, it will be tested for the first time from a naval vessel in 2019.[67] Deployment could start in 2022,[68] and is likely to be extensive. For example, the new Russian frigate *Project 22350M* will have 48 launch tubes capable of carrying the *Tsirkon*, although the vessel will probably end up carrying a mix of missiles.[69]

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In 2017, *TASS* reported that, according to a source in the Russian defense industry, "Tsirkon missiles can be launched with the help of a universal shipborne platform with ZS-14 launchers that are also used for Kalibr and Oniks missiles."[70] There probably is a linkage between this and recent reports that the *Tsirkon* is one of the hypersonic missiles that will be deployed in a ground-launched mode in 2020.[71] The *Oniks* is the missile that is ground-launched in the *Bastion* anti-ship/land attack system. It has a range, according to *Interfax*, of 600-km, making it a violation of the INF Treaty.[72] Substitution of the *Tsirkon* for the *Oniks* would result in a much longer range and faster missile.

The Avangard Hypersonic Boost Glide Vehicle

The *Avangard* hypersonic boost glide vehicle has taken over from the *Iskander-M* the status of posterchild of Russian strategic nuclear weapons. The Russians have stated that the *Avangard* is in serial production and will be operational this year. As noted above, President Putin has characterized its significance as comparable to the launching of the world's first artificial satellite in 1957.

The Russians describe the *Avangard* as being able to defeat any missile defense system. That is certainly true with regard to current Western missile defenses, but Russia does not need the *Avangard* for this purpose and that is not its main mission. Rather, the *Avangard*'s main mission is a surprise nuclear first strike against critical time urgent targets such as the U.S. national command authority, early warning capability and bomber bases. In this mission, the 50% reduction in flight time that General Hyten mentioned is of critical importance. This mission is vitally important for the Russian strategy of pre-emptive nuclear strike, something that has been confirmed by former Russian General Staff Yuriy Balyevskiy.[73]

The *Avangard*, formerly called Project 4202, uses the Soviet legacy SS-19/UR-100NUTTH ICBM, a very large ballistic missile, to boost the hypersonic glider.[74] The most likely reason for selecting the SS-19 is that the glider is too heavy to be carried by the much smaller but much more modern SS-27/*Yars* ICBM. The new Russian *Sarmat* heavy ICBM, now under development, is also reported to carry the glider as one of its warhead options. The reported speed of the *Avangard* is 24,000-km per hour.[75] *TASS* states that the missile carries a two-megaton nuclear warhead.[76]

The Sarmat is declared by Russia to have a mammoth ten tons of throw-weight and will reportedly carry 10 heavy or 15 medium nuclear warheads.[77] The *Sarmat* will clearly be Russia's main counterforce weapon. However, the claim that the *Sarmat* can carry 24 of the *Avangard* hypersonic gliders is manifestly untrue; the *Sarmat* has only about two and a half times the throw-weight of the SS-19, which is about 4,300-kg.[78] As a result, the report that the *Sarmat* can carry three to five *Avangard* gliders appears much more credible.[79]

Neither the SS-19 nor the *Sarmat* need hypersonic boost glide vehicles to penetrate America's very limited strategic missile defenses. President Trump has said that with two-on-one engagement of attacking warheads, U.S. missile defense can destroy an attacking missile 97% of the time.[80] That estimate, however, is clearly not against a Russian level offense, but rather the Third World threat the system is designed against. However, even if there were no missile defense countermeasures on Russian missiles, the 64 planned U.S. strategic missile defense interceptors could engage just 32 attacking Russia ballistic warheads.

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The Russians reportedly plan to deploy 12 *Avangard* launchers.[81] Since the *Avangard* is a single warhead missile, 12 launchers are equal to 12 warheads. The original configuration of the SS-19 carried four to six powerful nuclear warheads on each missile.[82] Twelve SS-19's with four to six warheads each would present the defense with 48-72 target warheads. This would guarantee 18 to 40 nuclear detonations in the U.S., as compared to 12 in the *Avangard* configuration. Regarding the *Sarmat*, four *Sarmat* missiles with 10 warheads each would more than exhaust the entire U.S. strategic missile defense system, resulting in eight Russian detonations in the U.S. With 15 warheads per missile, the number would rise to 28. With four *Sarmat* missiles carrying 3-5 *Avangard* payloads, there would be 12 to 20 detonations in the U.S.

The main mission for the Avangard is not to penetrate America's very limited U.S. missile defenses, however, but rather to destroy time urgent U.S. targets in a surprise nuclear attack. In this mission, the nuclear-armed Avangard would excel.

Moscow takes the lead

Russia has now achieved a monopoly on hypersonic missiles and, in the best-case scenario, will retain a monopoly on hypersonic intercontinental capability and on nuclear hypersonic missiles forever absent a change in U.S. policy. The Russians have linked their hypersonic capabilities to a decapitation attack on the U.S., which would likely be the first phase of an all-out nuclear strike. Their theater range hypersonic missiles will be a very serious warfighting threat to NATO as well as to U.S. forces in the Far East and Japan.

America's current situation is critical. At the moment, the United States has a complete lack of a deterrent or defenses against hypersonic missiles. This is a shortfall that needs to be rectified, and rectified quickly.

AFPC hosts lunchtime briefing series for Congressional Staff in the House and Senate, featuring presentations by noted subject matter experts focused on a wide array of defense technology issues. If you are a staffer interested in attending future briefings or would like to suggest briefing topics, please contact Defense Technology Programs director Rich Harrison via email at harrison@afpc.org.

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