A PRIMER ON CHINA's ANTI-SHIP BALLISTIC- AND CRUISE MISSILES

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For quite some time now, China has been arming itself — both with new hardware and new maritime operational concepts, typified by what the Americans (and increasingly, others, too) call 'Anti-Access and Area Denial' (A2/AD) — to challenge any adversarial dominance of the maritime areas of its interest. The US and its allies believe that China seeks to provide credibility to this A2/AD concept by rapidly developing warfighting systems based upon anti-ship ballistic missiles and anti-ship cruise missiles, supported by spaced-based capabilities as represented by the *Yaogan* series of surveillance-satellites, and the *BeiDou* navigation system. Irrespective of whether or not India subscribes to the A2/AD nomenclature, these technological developments have great significance within India's own maritime calculus. Consequently, it is imperative that these issues be studied in some detail.

Any such study must necessarily involve, as a preliminary activity, the collation of the generic, open-source information that is scattered across several sources, including assorted articles, analyses, reports, etc. This article represents precisely such a preliminary collation, and additionally makes an effort to explain the collated material in simple terms, from which a lay reader can gain a reasonable understanding of the subject. The analysis emanating from such a collation will be presented in the follow-on articles.

On 01 October 2019, the People's Republic of China (PRC) celebrated the seventieth anniversary of its founding. Notable amongst the pageantry was a military parade, in which the People's Liberation Army (PLA) demonstrated a highly orchestrated show of strength, exhibiting many of its strategic weapon systems.[1] The display served to highlight the technical sophistication and modernity of China's strategic missile force, its conventional precision strike capabilities, as also its prowess in terms of 'Information, Surveillance, and Reconnaissance' (ISR).

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[1] Ian Williams and Masao Dahlgren, "More Than Missiles - China Previews its New Way of War", *Centre for Strategic and International Studies, CSIS Briefs*, Oct 2019, www.csis.org

Much interest has since been evoked amongst military and civilian specialists, media pundits, and the lay public, too, in these advanced technological weapons and the associated systems being fielded by China, and, in the maritime concepts that underpin their development and deployment. China's development of anti-ship ballistic missiles, as well as anti-ship cruise missiles, both sets of which have the ability of transforming maritime warfare in the 21st century, is a good point at which to begin.

The Concept of Anti-Access/ Area Denial

It is reiterated that the terms 'Anti-Access' and 'Area Denial' are not expressions emanating from Chinese military doctrine but are popular US expressions. In 2003, the US Centre for Strategic and Budgetary Assessments (CSBA) defined 'Anti-Access' as "*enemy actions which inhibit military movement into a theatre of operations"*, and 'Area-Denial' operations as *"activities that seek to deny freedom of action within areas under the enemy's control"*. At one level, these are not much more than American variants of the more well-established terms, "Sea Control" and 'Sea Denial'. Terminological-provenance notwithstanding, the USA believes the concept to have been developed by China in order to 'sanitise' its maritime periphery and prevent the maritime forces of potential adversaries to dominate a given maritime space or area comprising international waters and the super-adjacent airspace. The USA appreciates that China's 'A2/AD Strategy' is based on area-denial weapons such as the *Anti-Ship Ballistic Missile* (ASBM).[2]

A2/AD Strategy vs Force Projection

Volume I of the RAND report entitled *"Smarter Power, Stronger Partners"*, explains that 'A2/AD' differs from 'force projection' and enjoys certain advantages over the latter. A2/AD capacities and capabilities are located mainly within the defender's homeland and deployed largely in its littoral waters, whereas 'force projection' requires moving platforms, often over great distances, and forcibly entering the defender's land, air, or littoral space. Hence, A2/AD forces are more able to absorb losses, exploit internal lines of communication, and keep or readily move forces into position.[3]

The RAND report under reference also emphasises that technologies needed to locate, track, and target high-value weapon platforms, such as ships and aircraft, are increasingly available with China. While targeting-technologies are also used in 'force projection', their advantages are more pronounced in A2/AD, since the latter is concerned mainly with locating, tracking, and striking weapon-platforms operating in open seas and skies (as opposed to defensive platforms that could well be hidden in cluttered terrain, as is the case with 'force projection'). Moreover, improvements in A2/AD technologies have been continuous and rapid, largely because they rely heavily on dual-

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[2] Gurpreet S Khurana, "PORTHOLE - Geopolitical, Strategic and Maritime Terms and Concepts", 8.
[3] Terrence K. Kelly, David C. Gompert, Duncan Long, "RAND report - Smarter Power, Stronger Partners, Volume I, Exploiting U.S. Advantages to Prevent Aggression", summary – xiii.

use technologies that are developed principally for civilian markets. Examples would include information technology (IT) and global positioning. In contrast, improvements in 'force projection' capacities are more likely to require entirely new preponderantly 'military' platforms and technologies, because they need to give primacy to combat-features such as stealth, electronic countermeasures, precision-strike, and so forth. There is, of course, a limit beyond which it is infructuous to segregate A2/AD and FP requirements, since there is, obviously, more than a little overlap between these categories of systems.[4] The RAND report concludes that China's burgeoning A2/AD capabilities, well supported and complemented by its satellite technology, will make it difficult for any adversary to undertake 'force projection' operations against the People's Republic of China.

PLA Rocket Force

China's Strategic Missile Force, previously known as the PLA Second Artillery Corps (SAC), was created in 1966. The SAC was an independent Service, but a grade lower than the regular land-forces, naval-forces, and air-forces of the PLA. On 31 December 2016, the Central Military Commission (CMC) elevated the Strategic Missile Force to the same level as the Ground Force, the Navy, and Air Force of the PLA, and renamed it the 'PLA Rocket Force' (PLARF).[5]

Organisation. Operational units of the PLARF are organised into 'bases', which are corps-sized units consisting of several missile-brigades. There are currently six operational bases, a training base, and, several support-, training-, logistics-, and engineering-units. The PLARF Headquarters is located at the Qinghe Compound in northwest Beijing, and it is responsible for overseeing administrative management, personnel affairs, recruitment, training, budget, etc. PLARF units across the country receive logistic-support from the regional PLA headquarters in which they are stationed, but receive their operational orders directly from the CMC through a four-tier chain-of-command comprising the CMC, missile bases, missile brigades, and launch battalions.[6]

With that brief backdrop having been established, it is pertinent to turn now to the missiles that the PLARF handles. These fall into two basic and globally-generic categories, namely, 'ballistic missiles' and cruise missiles', although there is now a hybrid that has appeared in the typology, as represented by the 'hypersonic glide vehicle' (HGV).

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[4] Ibid.
[5] China Defence Today, "PLA Rocket Force". www.sinodefence.com
[6] Ibid.

Ballistic Missiles

A ballistic missile is simply one that follows a ballistic trajectory to deliver its warhead onto its intended target. The warhead carried can vary greatly, and could comprise conventional explosives, biological, chemical, or nuclear payloads. Ballistic missiles may be propelled by solid or liquid propellants. Liquid propellants are cheaper, but less stable (and therefore more difficult to store) and more toxic. Solid propellants are more expensive, but more easily maintainable and more stable. Hybrid fuels that seek to combine the benefits of solid- and liquid-propelled ballistic-missiles are under continuous development.[7]

Flight Path and Trajectory. A ballistic trajectory may lie entirely within the earth's atmosphere, or, it may lie partially within and partially outside of it. The sub-orbital trajectory that a ballistic missile follows, in order to deliver its warhead to the target, comprises three segments: a powered initial-phase, a free-flight phase (which consumes most of the flight-time), and, a re-entry phase (in which the missile re-enters the Earth's atmosphere). Ballistic missiles can be launched from fixed sites, or from mobile launchers, aircraft, ships, or submarines. The duration of the powered-phase can vary from a few seconds to several minutes, depending upon the range to be achieved and the weight of the warhead. The initial thrust is provided by a single-stage or multi-stage rocket. The missile usually attains a high sub-orbital trajectory, entering free-flight in space. The highest point for an ICBM is 1,200 kilometres (km). In the re-entry phase, atmospheric drag plays a significant part in the missile's trajectory till impact. Ballistic missiles are characteristically easy to detect and track at launch but the hypersonic speed of the missile in its terminal phase presents a serious problem for defensive weapon systems. Interception in the terminal phase can be described as attempting to 'hit a bullet with another bullet', and the degree of difficulty of interception increases with the range and terminal velocity of the incoming missile.[8]

MIRVs and MaRVs. Longer-range ballistic missiles can carry Multiple Independent Re-entry Vehicles (MIRVs), whereby the missile's warhead contains multiple (up to 10) smaller warheads that re-enter the Earth's atmosphere at velocities of the order of 6-8 kilometres per second and each of which are capable of independent targeting. Being smaller, every such warhead is more difficult to intercept, and there are now 10 targets instead of one. Some countries are also developing Manoeuvrable Re-entry Vehicles (MaRVs) which, upon re-entry, effect a terminal-manoeuvres that facilitate the evading of anti-missile defences, while increasing the accuracy of their own targeting. In other words, an MIRV allows a ballistic missile to carry multiple-warheads that can be aimed at different targets within the same area, whereas an MaRV is capable of manoeuvring during re-entry, increasing its own accuracy against fixed and moving targets while enabling its own warhead to manoeuvre in flight and thus avoid interception by the adversary's missile-defence systems.

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[7] Missile Defence Advocacy Alliance (MDAA), "Missile Threat and Proliferation". https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/ballistic-missile-basics/.
[8] Air Marshal Narayan Menon, "Ballistic Missile Defence System for India,", Vol 27.3, Jul-Sep 2012, 31 May 2015, Indian Defence Review (IDR).

Classification of Ballistic Missiles. Ballistic Missiles are often categorised according to their range. A typical categorisation is as follows[9]: -

- Close-Range Ballistic Missile (CRBM), 50-300 km.
- Short-Range Ballistic Missile (SRBM), 300-1000 km.
- Medium-Range Ballistic Missile (MRBM), 1000-3000 km.
- Intermediate-Range Ballistic Missile (IRBM), 3000-5500 km.
- Intercontinental Ballistic Missile (ICBM), more than 5500 km.

Accuracy. The accuracy of a missile is quantified by a measure called 'Circular Error of Probability' (CEP), which is defined as the radius of a circle, centred upon the intended target, within which 50% of a large number of identical missiles, all operating without malfunction, would land. The CEP reflects the statistical 'median' rather than the 'mean', which implies that the CEP value itself does not make any statement about how far outside the radius the other half of the missiles will land.[10]

Hypersonic Weapons. The speed of sound in air is 344 metres per second (i.e., 1238 km/h or 770 mph or 668 knots) and is known as 'One Mach'. Hypersonic weapons are ultra-high-speed weapons that fly along the edge of military space (50 miles above Mean Sea Level) and accelerate to between Mach 5 and Mach 10. Given their rate of speed and non-ballistic trajectory, hypersonic weapons are difficult for current ballistic-missile defence-systems to intercept. Since 2014, China has carried out several tests of its HGVs.

The reasons why hypersonic weapons are considered to be deadly is because they combine the advantages of both, a ballistic- as well as a cruise-missile, in that they have the speed of a ballistic missile and the manoeuvrability of a cruise missile. Hypersonic weapons are specifically designed to defeat a modern ballistic-missile defence-system and to thereafter deliver conventional or nuclear payloads, at high velocities, over long ranges, in noticeably short durations of time. Hypersonic vehicles typically consist of a Supersonic Combustion Ramjet (SCRAMJET) propulsion-system to enable such high speeds. A Scramjet engine is one that uses 'air-breathing' technology, which means that the engine collects oxygen from the atmosphere while it is travelling, and mixes the oxygen with its hydrogen fuel, creating the combustion needed for hypersonic travel. This is different from a traditional 'ramjet', which is used on space shuttles and satellite launches. The traditional ramjet engine carries liquid oxygen, and hydrogen within it, adding a tremendous amount of weight to the vessel. Other options currently in development are the dual-mode ramjet (DMRJ), which works as a ramjet until the craft reaches a predesignated speed and altitude and works as a scramjet thereafter.

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[9] Missile Defence Advocacy Alliance (MDAA), "Missile Threat and Proliferation". https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/ballistic-missile-basics/.
[10] Ibid.

By using the DMRJ, the vessel can operate without a booster, which allows it to operate in a more clandestine manner.[11]

China's Ballistic Missile Program

China maintains a diverse and growing missile arsenal that it has been modernising over the past couple decades. It is in the process of phasing out its older ballistic missiles, such as the early variants of the *Dong Feng* (DF) series (the DF-3, and DF-4), replacing them with upgraded versions. As it upgrades its missiles, China is incorporating ballistic-missile technologies such as MIRV and MaRV. China acquired the technology and capability to develop and deploy MIRVs several decades ago, but Chinese leaders chose not to deploy missiles with this capability until recently. China has also developed a sea-based missile arsenal and, currently, the six Type 094/ *Jin* Class nuclear-powered ballistic-missile submarines carry up to 12 JL-2 submarine-launched ballistic missiles (SLBMs). According to the 2018 edition of the US Department of Defence Annual Report to the US Congress, on *"Military and Security Developments Involving the People's Republic of China"*, China's ballistic missile arsenal includes 1,200 SRBMs, 200-300 MRBMs, and 75-100 ICBMs.[12]

China's 'Anti-Ship' Ballistic Missiles

DF-21D (CSS-5 MOD 5). The DF 21 missile has four variants, viz., DF-21A, DF-21B, DF-21C, and DF-21D, which are also known as CSS-5 Mod 2, CSS-5 Mod 3, CSS-5 Mod 4, and CSS-5 Mod 5, respectively. Two these, the DF-21 C (land-attack variant) and the DF- 21D (anti-ship variant), carry only conventional warheads. The DF-21D is specifically designed to target ships at sea. Sometimes dubbed the "carrier-killer," reports suggest a range of 1,450 to 1,550 km (783-837 nautical miles [nm], which is taken, as a broad-average, to be 800 nm). Like the DF-21B, the warhead of the DF-21D is manoeuvrable and is reported to have a CEP of 20 metres. This missile entered service in 2006, along with the DF-21C. In 2013, the missile was tested against a ship target that was roughly the same size as contemporary U.S. aircraft carriers.[13] Reaching speeds up to Mach 10 during the terminal phase, the DF-21D is the fastest MRBM to date and can reportedly overcome existing US Ballistic Missile Defense (BMD) systems such as the sea-based AEGIS.[14]

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[11] Nitin J Ticku, "India, Japan Developing Hypersonic Missiles to Counter Looming Chinese Threats", *eurasiantimes, 16* March 2020
https://eurasiantimes.com/india-japan-developing-hypersonic-missiles-to-counter-looming-chinese-threats/.

[12] Missile Defence Advocacy Alliance (MDAA), "Missile Threat and Proliferation".
https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-proliferation/china/

[13] Missile Defence Project, "DF-21 (Dong Feng-21 / CSS-5)," Missile Threat, *Center for Strategic and International Studies*, 13 April, 2016, last modified 02 January, 2020, https://missilethreat.csis.org/missile/df-21/.

[14] https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-proliferation/china/dong-feng-21d-df-21d/

DF-26. The DF-26, which is depicted in **Figure 1**, is a road-mobile, two-stage, solid-fuelled, intermediate-range ballistic-missile (IRBM), with an anti-ship variant, the DF-26 B rumoured to have been test-fired in 2017, in the Bohai Sea. It has a range of 3,000-4,000 km (1620-2160 nm). The DF-26 has a 'modular' design, meaning that the launch vehicle can accommodate two types of nuclear warheads and several types of conventional warheads. The accuracy of the DF-26 is uncertain, with speculations estimating the CEP at intermediate range as being between 150-450 meters.[15]

Fig 1: DF 26
Source: Missile Threat, CSIS Missile Defence Project, www.missilethreat.csis.org

DF-17. The DF-17, which is depicted in **Figure 2**, is a short-to-medium-range ballistic missile, with an assessed range of between 1,800 and 2,500 km (972-1350 nm) and is equipped with a hypersonic glide vehicle (HGV) — the 'DF-ZF' (this used to be known, in US military circles, as the WU-14). The missile is solid-fuelled, measuring around 11 m in length, and weighing around 15,000 kg. Between January 2014 and November 2017, China conducted at least nine flight tests of the DF-17. Reports also suggest that China could develop the DF-17 into a second-generation ASBM.[16]

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[15] Missile Defence Project, "DF-26 (Dong Feng-26)," Missile Threat, *Center for Strategic and International Studies,* 08 January, 2018, last modified 31 January , 2020, https://missilethreat.csis.org/missile/dong-feng-26-df-26/.

[16] Missile Defence Project, "DF-17," Missile Threat, *Center for Strategic and International Studies,* 19 February , 2020, last modified 26 March, 2020, https://missilethreat.csis.org/missile/df-17/.
https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/hypersonic-missiles/

Fig 2: DF 17
Source: Missile Threat, CSIS Missile Defence Project, www.missilethreat.csis.org

Submarine-Launched Ballistic Missiles (SLBMs)

JL-2 (Ju Lang-2/CSS-NX-14). The JL-2 (CSS-NX-14), also known as the 'Julang-2' or 'Giant Wave-2', is a Chinese submarine-launched intercontinental ballistic-missile, with a three-stage solid propellant, which is depicted in **Figure 3**. China has armed each of its six *Jin* Class nuclear-armed and nuclear-propelled ballistic-missile submarines (two more are planned to be built and inducted) with twelve JL-2 ICBMs. The development of the JL-2 is believed to have begun in 1970, in tandem with the DF-31 land-based ICBM. The JL-2 has a minimum range of 2,000 km (1,079 nm), a maximum range greater than 8,000 km (4,320 nm), and carries a payload of 1,050 to 2,800 kg. The missile is believed to be armed with a single nuclear warhead of 'one-mega-tonne' (1 MT) yield, but may also be capable of delivering between three and eight lower-yield MIRV warheads. The JL-2 is reported to have a CEP of 150 or 300 m.[17] It is understood that the People's Liberation Army-Navy (PLAN) is also undertaking test firing of the next generation (JL-3) SLBM.

[17] Missile Defense Project, "JL-2 (Ju Lang-2/CSS-NX-14)," Missile Threat, *Center for Strategic and International Studies*, 12 August , 2016, last modified 07 October , 2019, https://missilethreat.csis.org/missile/jl-2/.

Fig 3: JL 2 SLBM
Source: Missile Threat, CSIS Missile Defence Project, www.missilethreat.csis.org

Cruise Missiles

Brief Overview. Cruise missiles differ from ballistic ones in that they do not follow a ballistic trajectory, but are propelled towards their target, remaining within the Earth's atmosphere throughout their trajectory. Cruise missiles are capable of being launched from ground-based and airborne platforms, as also from sea-going and submarine ones.[18]

Propulsion and Flight. Cruise missiles utilise jet engines as their primary method of propulsion. Most such missiles are subsonic and use 'turbofan' or 'turbojet' engines. Although less commonly encountered, supersonic and hypersonic cruise missiles also utilise Ramjet and Scramjet engines. Some use rocket-motor propulsion as a booster for the first phase of their flight, or to accelerate to supersonic speeds in the terminal phase. The trajectory of most cruise missiles remains close to the Earth's surface, sometimes skimming just a few metres above the ground. However, some fly at high altitudes and dive sharply during the terminal phase.[19]

Guidance. Cruise missiles can use any of a variety of guidance-methods (often combining more than a single method) in order to accurately strike the target and evade missile-defence systems. One

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[18] Missile Defence Advocacy Alliance (MDAA), "Missile Threat and Proliferation". https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/cruise-missile-basics/
[19] Ibid.

of the earliest methods used (but one which is still in contemporary use) by cruise missiles is 'inertial guidance', effected via an Inertial Navigations System (INS), which allows the missile to fly along a pre-programmed flight-path. Another guidance-method is 'Terrain Contour Matching' (TERCOM), which compares a terrain-map stored in the missile's electronic-memory to the actual terrain over which the missile is flying. Some cruise missiles use GPS or other satellite-based navigation systems to generate position and, accurate time. Specific guidance-methods are used in the terminal phase of flight to increase the missile-accuracy. In 'TV-guidance', for instance, an operator uses a camera in the nose of the missile to visually identify and manually guide the missile to the target in its final phase. In 'Infrared (IR)-guidance', on the other hand, the missile is directed towards heat-emitting objects. Likewise, a 'radar seeker' is also commonly used to guide the missile to an enemy radar installation that is transmitting and seeking to locate the incoming missile. 'Digital Scene-Matching Area-Correlation' (DSMAC)-guidance uses a camera in the missile to find the desired target but, instead of relaying images to an operator, matches them to a stored-set of images, using an image-correlator.[20]

Payload. Cruise missiles are typically armed with conventional or nuclear warheads, but can also be equipped with chemical or biological ones.

China's Anti-Ship Cruise Missiles

YJ-12. First revealed in 2015, the YJ-12 is an air-launched, ramjet-propelled, supersonic, anti-ship cruise missile, with an estimated range of 500 km (270 nm). China deploys them on its H-6K medium-range strategic bomber aircraft, making them the longest-ranged ASCMs, with the added ability to travel at speeds of up to Mach 3 (1 Mach is the speed of sound in air and = 343 metres/second). The naval variant of the H-6K strategic bomber is the H-6J, which, despite its letter-suffix, is actually a later development of the H-6K. The H6J replaces the older H-6G and is thought to be carrying over three times the number of anti-ship missiles — seven YJ-12 supersonic anti-ship cruise missiles (ASCM) — six on wing pylons plus one in the bomb bay. Despite the increased payload, the H6-J has an increased combat radius.[21]

YJ-12B. The YJ-12B, depicted in **Figure 4**, is a shore-based variant of the YJ-12, and garnered considerable international interest after it was revealed, in 2017-18, that these missiles had been deployed on Fiery Cross Reef, Subi Reef, and Mischief Reef, in the Spratly Islands

YJ-18. The YJ-18, also depicted in **Figure 4**, is a subsonic, anti-ship missile, with an estimated range of between 220 km (119 nm)and 540 km (292 nm). It is capable of being launched from airborne, surface, or ground-based platforms. After 'cruising' towards the target under turbojet propulsion, the YJ-18 releases a rocket-propelled warhead, which accelerates it to supersonic velocities.

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[20] Ibid.

[21] Jeremy Chin, "China's PLANAF Acquires New H-6J Bomber," Missile Threat, *Center for Strategic and International Studies*, 12 October, 2018, last modified May 8, 2019, https://missilethreat.csis.org/chinas-planaf-acquires-new-h-6j-bomber/.

YJ-100. The YJ-100 is a 2015-vintage, air-launched, anti-ship variant of the air-launched CJ-10 land-attack cruise missile (the latter is sometimes called the 'Chinese Tomahawk'), and is designed to be delivered by the H-6 series of bombers. The YJ-100 cruises at high subsonic speed and has a reported range of 650 km (350 nm). The guidance-system combines an Inertial Navigation System (INS) and a BeiDou Satellite-based navigation system for mid-course guidance, while for the terminal phase, it utilises an active radar-seeker.[22]

Fig 4: YJ-12 B and YJ-18
Source: Missile Threat, CSIS Missile Defence Project, www.missilethreat.csis.org

HD-1 Supersonic Cruise Missile. On October 15, 2018, China's Guangdong Hongda Mining Company test-fired its new 'HD-1' supersonic cruise missile. With a reported range of some 290 km (157 nm), a reported range of speed between 7.8 Mach and 12.6 Mach, and a sea-skimming altitude range of 4.8-9.7 metres, the HD-1 is expected to compete in the international defence market with the India-Russia joint-venture 'BrahMos' cruise missile.[23]

Arms Control Treaties

Arms-control treaties are a deeply studied subject, with rich analytical literature being readily and freely available. The following paragraphs merely offer a very brief, even superficial, recapitulation of the main highlights.

Anti-Ballistic Missile (ABM) Treaty. The ABM Treaty was a 30-year commitment signed by the USA and the erstwhile Soviet Union in 1972, with the two signatories undertaking to limit their respective Anti-Ballistic Missile (ABM) systems, so as not to destabilise the balance of power.

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[22] Deagel.com Website, "Offensive Weapons: YJ-100", -07 April, 2017, http://www.deagel.com/Offensive-Weapons/YJ-100_a002939001.aspx .

[23] Jeremy Chin, "China Test Fires HD-1 Supersonic Cruise Missile", Missile Threat*, CSIS Missile Defence Project*, 18 October 2018.
https://missilethreat.csis.org/china-test-fires-hd-1-supersonic-cruise-missile/

Under the terms of this treaty, each side was obliged to possess not more than two ABM complexes, each limited to 100 ABMs. However, in June of the year 2002, upon expiry of the 30-year period, the USA withdrew from the treaty.[24]

Strategic Arms Limitation Talks (SALT). Successive rounds of talks between the United States and the erstwhile Soviet Union, on limiting strategic weapons, eventually led to two agreements, namely, 'SALT 1' and 'SALT 2'. The SALT 1 negotiations, which commenced in 1969, led to freezing the number of strategic ballistic missile launchers at existing levels, and also paved the way for the *Anti- Ballistic Missile* (ABM) Treaty mentioned earlier. Negotiations between 1972 and 1979, led to SALT 2, which sought to reduce the number of strategic nuclear weapons held by both protagonists, and did, indeed, conclude with an agreement. However, the United States responded to the Soviet invasion of Afghanistan by refusing to ratify the treaty and the agreement expired in 1985. Nevertheless, the SALT negotiations were not entirely without result and they led to the *Strategic Arms Reduction Treaty* (START).[25]

Strategic Arms Reduction Treaty (START). START is a collective acronym for what were really a series of bilateral treaties between the United States and Russia, at about the point in time when the erstwhile Soviet Union was breaking-up, on reducing strategic weapons.

- START-I, which was signed in July of 1991 and implemented in 2001, capped the nuclear warheads on each side to 6,000 and *Inter-Continental Ballistic Missiles* (ICBM) to 1,600. It expired in December of 2009.

- START-II, which was signed in January of 1993, represented an agreement to ban the use of *Multiple Independently Targetable Re-entry Vehicles (MIRVs) on ICBMs,* but it never entered into force. Although both countries initially ratified it, Russia withdrew from START-II in response to the US withdrawal from the *Anti- Ballistic Missile* (ABM) Treaty, in 2002.

- As a kind of replacement of START II, the '*Strategic Offensive Reductions Treaty*' (SORT) came into force in June of 2003, which committed both countries to reduce their respective strategic warheads to 1,700 -2,200.

- SORT itself was superseded by a 'New START' treaty, signed in April of 2010. This stipulated a reduction of strategic nuclear missile launchers to half the existing number. The 'New START' came into in force in January of 2011, and, is expected to remain in force for at least 10 years. [26]

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[24] Gurpreet S Khurana, "PORTHOLE - Geopolitical, Strategic and Maritime Terms and Concepts", 8.
[25] Gurpreet S Khurana, "PORTHOLE", 185.
[26] Gurpreet S Khurana, "PORTHOLE", 185.

The Intermediate-Range Nuclear Forces (INF) Treaty. The Intermediate-Range Nuclear Forces (INF) Treaty of 1987, between the United States and the erstwhile Soviet Union, required them to permanently eliminate all nuclear and conventional ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 kilometres. The treaty was, in effect, a commitment between the two superpowers to not merely reduce their respective nuclear arsenals, but permanently eliminate an entire category of nuclear weapons, and employ extensive on-site inspections for verification. On 02 August 2019, however, the USA formally withdrew from the INF Treaty, and shortly thereafter, the Russian President, Vladimir Putin, also announced that Russia, too, would officially suspend its treaty obligations.[27]

Effect of Modern Cruise and Ballistic Missiles upon Naval Combat

Maritime forces in general, and warships in particular, have several significant intrinsic attributes. Amongst these are access, mobility, sustenance, reach, and versatility. These enable the deployment of maritime forces in areas of interest, largely without constraint. The US believes that through the development of robust A2/AD capabilities, well-supported and complemented by satellite technology, China is making it difficult for maritime forces to exploit these inherent attributes. In other words, US maritime forces may no longer be able to operate close to the Chinese coast with impunity. The ranges of modern-day ASBMs and ASCMs place severe constraints on the freedom-of-navigation and freedom-of-action that the US Navy is accustomed-to, and accordingly impacts US maritime strategy, doctrine, tactics and force structuring. This requires the US Navy to undertake some serious rethinking and restructuring, if it is to negate the advantages that the Chinese now appear to increasingly enjoy. While the efficacy of China's A2/AD capability may well be open to debate, it would be prudent to accept that the technologies underpinning the strategy have matured and China is exploiting these technologies effectively. The ability of the PLARF to challenge the US Navy's ability (or that of NATO) to influence maritime affairs is a manifestation of what is sometimes called a 'Mature Precision Strike Regime' (MPSR), a subject that has been extensively dwelt upon by strategists such as Dr Andrew Krepinevich of the USA.[28]

Conclusion

In conclusion, it is reiterated that this article has been penned with the limited aim of providing a ready-reckoner that provides 'baseline-information', and is the precursor of what will be a more granular assessment of the technologies underpinning contemporary and future operational-concepts of the Chinese Navy.

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[27] Arms Control Association, "The Intermediate-Range Nuclear Forces (INF) Treaty at a Glance". Last Reviewed 19 August 2019.
https://www.armscontrol.org/factsheets/INFtreaty(

[28] Dr Andrew F Krepinevich, "Maritime Warfare in A Mature Precision-Strike Regime", Center for Strategic and Budgetary Assessments, 2014, https://www.files.ethz.ch/isn/190270/MMPSR-Web.pdf

China, one of the five nuclear weapons states under the Non-Proliferation Treaty (NPT), is estimated to possess 320 nuclear warheads,[29] an arsenal that has steadily increased in recent years. Beijing has built a credible missile force and has simultaneously sought to modernise and expand its nuclear delivery systems, which includes numerous nuclear-capable land-based missiles, along with a limited number of submarines, SLBMs, and strategic bombers. China's stated nuclear policy has been to keep its capabilities at the minimum level required to maintain its national security and to deter a potential first strike. It was the first nation to declare a "No First Use" policy.[30] During the 1995-96 Taiwan Strait Crisis, the SAC fired a total of ten DF-15 SRBMs into the international waters off the Taiwanese coast, in an obvious show of intimidation and coercion.[31] China continues to default on its commitment to create and sustain a rules-based order whose rules are devised through international consensus, rather than unilaterally. Chinese coercive diplomacy has become more pronounced of late, and, its assertiveness is transforming into aggressiveness. It is, therefore, imperative for countries such as India, Japan, Australia, the USA, Singapore, Indonesia, Vietnam, and several countries of the European Union, all which believe in an internationally-derived rules-based order, to offset China's growing capabilities through concerted development of their own indigenous and shared technology, which is capable of being applied at the strategic, operational, and tactical levels.

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[29] SIPRI YEARBOOK 2020, "Armaments, Disarmament and International Security summary", Nuclear Arsenals, 14.
[30] Arms Control Association, "Arms Control and Proliferation Profile: China". Last Reviewed July 2017. https://www.armscontrol.org/factsheets/chinaprofile
[31] CHINA DEFENCE TODAY, PLA Rocket Force