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Forecast of Chinese SSBN force levels

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ABSTRACT

Nuclear-powered Ballistic Missile Submarines (SSBNs) remain the mainstay of credible nuclear deterrence. Owing to the limited information emerging from China, even the number of SSBNs in service with the PLA Navy at present remains an estimate. Projections or forecasts of Chinese SSBN force levels in the next 10–20 years are therefore speculative and widely deviating. Based on the analysis of China's professed nuclear policy, possible SSBN deployment patterns, and developing shipyard infrastructure, this paper assesses the capacity as well as perceived requirement of Chinese SSBNs. Accordingly, the author offers forecasts for SSBN force levels by 2030 and by 2040. Likely technological developments and characteristics of the next-generation Type 096 SSBN are also predicted.

KEYWORDS

China; SSBN; submarines; force levels; ballistic missiles; shipbuilding; nuclear doctrine; deterrence

Introduction

The Chinese SSBN programme is shrouded in secrecy and has been analysed mainly through the prism of U.S. security concerns. The progress, status and likely future trajectory of the SSBN programme need to be examined in order to assess implications on the security of India and the other nations in the Indo-Pacific region.

This study aims to examine the likely future trajectory of the Chinese SSBN programme over the next two decades (till about 2040). This would enable assessment of ramifications for the geostrategic scenario in the Indo-Pacific in general and in particular, the imperatives for India's strategic deterrence programme.

The governing factors including doctrinal motivation, technological challenges, construction capabilities, operational efficacy and likely deployment patterns of Chinese SSBNs are touched upon in the first part of the paper. With this perspective and understanding of Chinese national ambitions and military strategy, the paper attempts to forecast developments in Chinese undersea capability in the next 10–20 years, that is, till about 2040. The modernisation and expansion of the SSBN force and its capabilities would be driven by the need to maintain and improve the credibility and survivability of its second-strike capability. This is a continuing challenge due to advent of new technologies and the need to match tactics and strategies of adversaries.

The second part of the paper summarises predictions from various sources regarding number of likely platforms (submarines of various types). The pace of construction and the

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shipyard infrastructure developments are analysed, and number of likely platforms based on existing or future construction capacity is projected. However, platforms are built not merely based on construction capacity, but more importantly, based on perceived needs (and consequent funding priority). The final section of the paper therefore assesses the number of SSBNs that China is likely to maintain in order to meet its national objectives, nuclear doctrinal requirements and likely deployment patterns. A forecast of build-up of numbers and types of Chinese SSBNs over the next twenty years is presented. The likely characteristics of the next-generation Chinese SSBN are also predicted, linked to this assessment.

Governing factors

Nuclear doctrine and significance of SSBNs

Ever since its first nuclear explosion, the Chinese policy on nuclear weapons has been declared as that of "No First Use" (NFU).[1] It has been argued that the Mao era did not develop a cogent nuclear doctrine and was grappling with technological challenges.[2] China's highest leaders, including Mao Zedong and Deng Xiaoping, espoused the concept of a "strategy of assured retaliation."[3] The Chinese White Paper on Defence in 2008 states that "China has always stayed true to its commitments that it will not be the first to use nuclear weapons at any time and in any circumstances, and will unconditionally not use or threaten to use nuclear weapons against non-nuclear weapon states or in nuclear-weapon-free zones."[4] The Chinese White Paper of 2015 on military strategy, outlining a new policy of "active defence," states that "the PLA Navy will enhance its capabilities for strategic deterrence and counterattack."[5] Some Chinese analysts have expressed the opinion that China should review its policy of NFU in order to have flexibility of response to an unacceptable level of conventional threat as well.[6]

Sea-based nuclear weapons reduce the reaction time available to an adversary, due to launches taking place closer to their territory (compared to land-based ICBMs). The direction of launches can also be varied, posing a greater challenge to any missile defence system, which are easier to focus on expected directions of attack.

In a recent study of Chinese literature on the subject, Zhao brings out the perception of Chinese strategists that SLBMs are less vulnerable than other nuclear delivery systems proceed from several understandings about SSBNs. First, SSBNs are highly mobile and can considerably "expand the combat area" by patrolling in open oceans and thus "increase the [geographical element of] surprise" of an attack. Second, SSBNs can be extremely stealthy. Detecting and tracking enemy SSBNs requires a tremendous amount of military resources. Consequently, pre-emptively destroying SSBNs is "more difficult than destroying land-mobile launch systems."[7]

Chinese strategists have also been influenced by the trend that every other nuclear weapon state that has signed on to the Nuclear Non-Proliferation Treaty (NPT) has increased the role of sea-based nuclear weapons in its nuclear posture, and the proportion of sea-based nuclear capability in national nuclear deterrent systems will continue to rise. Chinese strategists point out that "nuclear submarines armed with strategic nuclear missiles are the most ideal type of nuclear retaliation capability."[8] In short, Chinese analysts generally perceive SSBNs as befitting a country of China's stature.

The relative significance of China's sea-based nuclear force has grown rapidly after the Type 094 (*Jin*) class of SSBNs entered service from 2007. Chinese SLBM launchers constitute 48% of all Chinese ballistic missile launchers that could potentially launch strikes against the continental United States,[9] as shown in Figure 1.

Construction progress

The chequered history of Chinese nuclear submarine and ballistic missile developments dates back to design commencing in 1958. Construction of the first Type 091 or *Han* class SSN started in 1967, and entered service in 1974.[10] Five of these SSNs were commissioned between 1974 and 1991.

The first SSBN, Type 092 (*Xia*) was a technology demonstrator that utilised the experiences of the *Han* SSN design and construction to integrate the SLBM into the nuclear-submarine platform. The first iteration of design was ready by 1967.[11] Construction of the first SSBN (Type 092) started in 1971[12] and it was commissioned in 1983. However, it is understood to have never been deployed on a deterrent patrol. The platform faced numerous problems: high noise levels and radiation leakage, not to mention the short range of the single warhead carried by the first-generation submarine-launched ballistic missile (SLBM), the *Julang*-1 (JL-1).[13]

With the *Jin*-class (Type 094) entering service from 2007, China's sea-based deterrence began to gain credibility.[14] The fourth *Jin*-class SSBN entered service in 2015 and the fifth is likely to have entered service in 2018.[15]

The main characteristics of the classes of SSBNs, including the future Type-096 (discussed subsequently) are summarised in Table 1. The first-of-class of Type 094 began sea trials in early 2006 and was ready for deployment in early 2007. All SSBNs are now based at Yalong Bay (Hainan Island) with the South Sea Fleet. It is reported that full operational capability was delayed until the JL-2 missile completed its test firings in 2008–2012, but another test firing was conducted in January 2015.[16] Its first deterrent patrol was most likely conducted in 2016.

The second Type 094 SSBN was launched around 2006, conducted trials in 2008 and entered service around 2010. The third boat was launched in late 2009 and entered service around 2012. The fourth was launched around 2011, commenced trials in 2013,

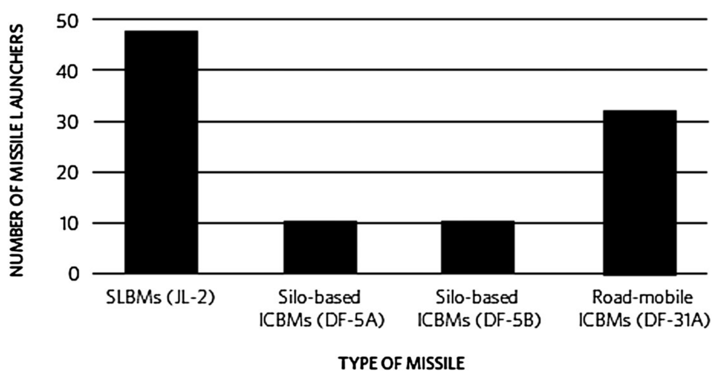

Figure 1. Estimated number of Chinese ballistic missile launchers that could strike US mainland.

Note: Hans M. Kristensen and Robert S. Norris, "Chinese Nuclear Forces, 2018," *Bulletin of the Atomic Scientists* 74, no. 4 (25 June 2018): 289–95, https://www.tandfonline.com/doi/full/10.1080/00963402.2018.1486620 (accessed October 10, 2018).

Table 1. Main characteristics of Chinese SSBN classes.[a]

Class	Designed	Entered Service	Displace-ment (Tons)	Quantity Built	No. of SLBMs	SLBM Type	Range (km)
Type 092 (Xia)	1970s	1987	8,000	1	12	JL-1	1200/1770 (?)
Type 094 (Jin)	Early 1980s	2007	12,000	4/5?	12	JL-2	7400/8000 (?)
Type 096 (Tang)	Reportedly in progress	Early 2020s	18,000?	NIL	24?	JL-3	12/14 /16,000 (?)

[a]Cmde Stephen Saunders, *Jane's Fighting Ships 2016–17* (IHS Jane's, 2016); John Pike, "Type 092 Han-Class SSBN," *GlobalSecurity.org*, August 18, 2016, https://www.globalsecurity.org/wmd/world/china/type_92.htm (accessed November 1, 2018); and John Pike, "Type 094 Jin-Class SSBN," *GlobalSecurity.org*, February 4, 2018, https://www.globalsecurity.org/wmd/world/china/type_94.htm (accessed November 1, 2018).

and entered service in 2015. Thereafter, there appeared to be a pause in construction, with the first Type 093 SSN being reported.[17] A fifth (and perhaps final) Type 094 boat was started around 2008 and was likely to have been launched in 2016 and possibly entered service in 2017/18. The timelines for construction of first-of class SSBNs are summarised in Table 2.

Geographical constraints and likely deployment

The geography of the Chinese coastline, its surrounding islands and the depths of waters in the Yellow Sea, East China Sea and South China Sea impose significant constraints on Chinese naval operations. In order to enter the Pacific or Indian Oceans, Chinese submarines would have to transit one of several straits, which are prone to be monitored. For transit to the Pacific, the SSBNs need to pass through the Taiwan-Luzon area before reaching the Western Pacific, within SLBM strike range for the continental U.S.[18] The restrictions on submarine deployment become even more apparent on examining the depth contours of the region. The sea becomes too shallow for submarines (less than about 100 metres) south of Natuna Islands. The South China Sea is the largest and most suitable body of water along China's coastline for basing its SSBNs. Passage to the Indian Ocean is similarly restricted. For submerged passage to the Indian Ocean as well, PLAN submarines would need to transit through the Lombok or Ombai-Wetar straits.

It has been reported that the U.S. and Japan have a system of seabed arrays to detect passage of submarines through choke points, particularly along the East China Sea. It may be anticipated that similar systems may exist along the Philippines as well.

With this backdrop of maritime geography constraints, it becomes essential for China to control the South China Sea to ensure undetected movement of its SSBNs. All Chinese SSBNs are based at Yalong Bay on Hainan Island with the South China Sea Fleet,[19] even though all nuclear submarines are built in the North at Huludao.

Table 2. Timelines of construction of first-of-class Chinese SSBNs.[a]

Class	Construction Started	Launched	Commissioned	First Missile Launch	De-commissioned
Type 092 (Xia)	1978	1981	1981 (Entered service 1983)	1988	2010
Type 094 (Jin)	1999/2001?	2004	2007/2010?	2015	–

[a]Compiled from Saunders, *op.cit.*; Pike, *op.cit.*; "Jin Class," *Military Today*, 2018, www.military-today.com/navy/jin_class.htm (accessed November 1, 2018); and other sources.

China has improved and expanded its political administration and military occupation of maritime territory throughout the South China Sea. This includes the creation of islands with deep-water ports, runways, and various other administrative and storage facilities throughout the Spratly Islands along the western edge of the South China Sea. This territorial expansion facilitates unimpeded deployment of its SSBN force, due to the depth of water available and the approaches to the Pacific as well as Indian Oceans.[20] China's growing power projection capability and newly built dual-use infrastructure on Hainan, the Paracel Islands, and the Spratly Islands are enhancing its capacity to protect SSBNs deployed in nearby waters.[21]

The occupation of islands, creation of artificial islands in the South China Sea and development of infrastructure on them by China is therefore considered to be driven primarily by its SSBN credibility imperatives, rather than its surface fleet operations or economic considerations of the EEZ. As China's SSBN force continues to expand and receive upgrades, this could lead to China deploying a global-reach nuclear deterrent from within the South China Sea.

It is in this context that the South China Sea is opined to be a "bastion" for SSBNs. This would not only be able to cover (much of the) U.S. and (entire) India within SLBM range, but also be patrolling in relatively deep waters. Depths increase beyond 250 metres about 100 miles from Hainan and increase further beyond 2000 metres for most of the South China Sea, except around the Paracel and Spratly islands, and hence the imperative to keep these islands under Chinese control.

Force level predictions – review

Pace of construction and capacity

China has built nuclear-powered submarines in small numbers and at annual rates of less than one per year. Excluding the 12 *Kilo*-class purchased from Russia, 44 indigenously built submarines entered service between 1995 and 2016, at an average of 2.05 per year.[22] As shown in Figure 2, the pace of construction of major surface combatants (destroyers, frigates, and corvettes) has been greater since 2010.

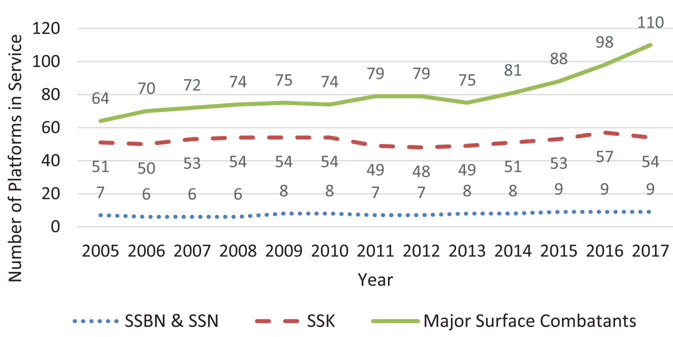

Figure 2. Number of major platforms in PLA navy service since 2005.

Note: Analysed using data from: Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, Congressional Research Service, August 1, 2018, https://www.hsdl.org/view&did=814688 (accessed November 20, 2018), 71.

However, while the number of submarines has not increased as fast as surface ships, the percentage of modern units within China's submarine force has increased from less than 10% during 2000–2004 to about 47% in 2008, 50% in 2009[23] and may exceed 75% in 2020.[24] Based on the greater emphasis being given to surface ship programmes, it could be possible that the existing or augmented submarine production capacities are used for qualitative improvements and replacing older boats. As against the maximum projection of 64 submarines, the minimum estimate for number of operational submarines in 2020 could remain close to existing levels of around 58 boats (At least four SSBNs, six SSNs, and 48 SSKs).[25]

So far, all nuclear submarines have been built at the Bohai Shipyard in Huludao in Northern China. Satellite imagery revealed that the Bohai Shipbuilding Heavy Industry Company (BSHIC) has been undergoing significant expansion since 2014, including reclamation of land, building of covered sheds and laying of rails. In a recent article,[26] it has been analysed based on satellite imagery that the capacity of the expanded shipyard should be enough to build two SSBNs and up to four SSNs simultaneously. Once the production process has matured, with efficient pre-assembly module fabrication, this may enable two SSNs and one SSBN to be launched every year. Whether such production levels are reached or not, the capacity that is being created appears to be futuristic and scalable.

Based on overall assessment of inputs from various sources regarding number of platforms under construction, Erickson[27] has compiled the overall build-up and forecast of force levels of the Chinese naval forces, summarised in Table 3. The number of SSBNs is projected to increase sharply from 4 or 5 in 2020–12 in 2030, with similar increase in SSN numbers. While this is feasible from the viewpoint of construction capacity, the projected force levels will now be reviewed in terms of anticipated requirements.

Force level projections based on requirements

China has recently (in the past 5 to 10 years) enhanced nuclear forces building and modernisation, and both international and domestic factors are likely to accelerate this pace. As per a RAND Corporation report of 2017,[28] Chinese nuclear planners are concerned about strategic developments in the United States, especially the deployment of missile defences. Within the region, the improving nuclear capabilities of China's neighbours, especially India, could be a growing concern for Beijing.

U.S. studies have suggested that a force of at least *five* SSBNs is required to maintain one on continuous deterrent patrol,[29] which is the current estimated strength of the Chinese

Table 3. China's primary naval order of battle (major combatants), 1985–2030.[a]

Year	SSBN	SSN	SS	Total Submarines	Total Surface Ships
1985	1	2	100	103	369
1990	1	4	88	93	329
1995	1	5	43	49	272
2000	1	5	60	65	110
2005	2	6	51	57	158
2010	3	6	54	60	214
2015	4	5	53	62	232
2016	4	5	57	66	237
2020	4–5	6–9	59–64	69–78	244–264
2030	12	12	75	99	316

[a]Erickson, Chinese Naval Shipbuilding, *op.cit.*, xvi.

SSBN fleet. The total number of SSBNs aimed for by China needs to be examined from the perspective of their likely deployment strategy.

Based on the historical data of SSBN forces of the other four navies (U.S., Russia, UK, and France), Yoshihara and Holmes have opined that "As the British and French models show, the threshold for sufficiency would be quite low for China."[30] The "sufficiency" here refers to the minimum number of SSBNs required, as per the underlying principle of "minimum deterrence," that as long as the number of surviving retaliatory weapons after a disarming first strike is not zero, then the posture may be considered credible. Accordingly, they state: "In theory, even if all of China's land-based deterrent were destroyed in a first strike, a single SSBN armed with multiple re-entry warheads would need to survive a 'bolt from the blue' to conduct a retaliatory strike."[31] This is likely to be strategically unacceptable for the U.S.

Since China does not face a threat of pre-emptive nuclear strike from India (due to policy of NFU), it needs to deal with only one threat axis, from the Pacific (U.S.). Further, a single SSBN on patrol may be adequate to evade the existing strategic ASW that may be applied against it. A counter-SLBM capability is also not likely in the near future, with BMD yet to mature to take on missiles launched by submerged SSBNs.[32] All these arguments support the premise that at least one remaining SSBN after a first strike would be adequate for China.

To maintain one SSBN on patrol, at least three more SSBNs would be required, with one undergoing long maintenance period, one under short maintenance period and another undergoing trials or training. This is the broad justification for UK and France to maintain a force of at least four SSBNs each. It is notable that UK's Royal Navy had sought to build a force of five SSBNs for redundancy, which was cut back due to financial considerations.[33]

If one considers that enemy ASW is, say, 50% effective, this would necessitate two SSBNs to be on patrol at any given time, which would require a total force of at least six SSBNs (considering maintenance and training). Based on the above arguments, China would need five to six SSBNs to meet its requirements of minimum credible deterrence against both U.S. and India.

However, Zhao reports a much higher number of SSBNs being recommended by some retired senior Chinese military officers: "For example, retired Rear Admiral Yin Zhuo stated in 2014 that, within the next eight to twelve years, China will need at least eight SSBNs. A retired Major General (Zhu Chenghu) went even further and argued that, to deter any country from launching a nuclear first strike against China, Beijing will need to maintain three to five SSBNs on patrol constantly. If that is the case, China would need to possess about eight to fifteen SSBNs, given the constraints imposed by maintenance requirements. If China were to follow the advice of these experts, it would end up with a substantially larger SSBN fleet than the UK and France and might even surpass the size of the U.S. and Russian fleets."[34]

Force prediction in 2006

In a study in 2006, Saunders and Yuan[35] predicted three progressive scenarios (or stages) of Chinese Strategic forces modernisation: "The first involves steady improvement of existing forces at a measured pace, focusing on improving survivability of nuclear forces via greater mobility, shortened launch preparation time, improvements in command and control, and protection or concealment of hardened silos." This modernisation (predicted by 2010) has already been going on and is likely to continue in any case. The second stage (2020) would be to counter U.S. missile defences [NMD: Nuclear Missile Defence; more commonly known as BMD: Ballistic Missile Defence] by "increasing force levels to maintain minimum deterrence." This would possibly see significant increase in Chinese missiles able to reach U.S. targets, along with development of MIRVs to overcome U.S. missile defences. The third stage (2020–25) could be driven by doctrinal change beyond "minimum deterrence," to a "limited deterrence" strategy or a "launch-on warning posture." Table 4 summarises these three scenarios/ stages for China's likely force structure and capabilities. In hindsight, it appears that "Scenario 2" of Table 4 has proved to be a somewhat accurate forecast.

Forecast of force levels: this study

Ten years from now, it is likely that an even greater degree of conventional naval power (including two more aircraft carriers and several other surface combatants now under construction), as well as technological prowess in the undersea domain (through unmanned vehicles and seabed sensors) may enable the coordinated and escorted deployment of Chinese SSBNs beyond the first island chain in larger numbers, maybe up to three at a time. This would enable targeting with a very high degree of survivability of the platform and penetrability of SLBMs, negating any further advances in BMD. These developments would be in keeping with the "China Dream"[36] of becoming a "world-class" military by the year 2049 or 2050.

The study summarised in Table 4 had focused on technological advances and deployment of land-based ballistic missiles. Based on the data collected and discussed in this study, a similar forecast for the growth of SSBN forces over next two decades has been undertaken and is given in Table 5, which is elaborated in the succeeding paragraphs.

Three stages of growth have been forecasted in the above Table, from the present (2019) till 2040, based on the analysis of Chinese nuclear doctrine, SSBN deployment patterns and needs/capabilities in SLBM development described so far in this study. These are

Table 4. Projections in 2006 for China's modernisation of its strategic forces.[a]

Parameter	Forces in 2006	Scenario 1: Minimal Deterrent (2010)	Scenario 2: Minimal Deterrent with NMD (2020)	Scenario 3: Doctrinal Change (2020–25)
ICBMs	18–26 (DF-5A)	About 50 (DF-5A, DF-31, DF-41)	100–200 (DF-5A, DF-31, DF-41)	100–200 (DF-5A, DF-31, DF-41)
Range (km)	13,000+	13,000+ (DF-5A)	13,000+ (DF-5A)	13,000+ (DF-5A)
CEP (km)	0.5–3.0	0.7–0.8	0.7–0.8	0.7–0.8
Mobility	None	Road Mobile	Road Mobile	Road Mobile
Advanced Early Warning	No	No	No	Yes
Launch-on-warning	No	No	No	Possible
Multiple Re-entry Vehicles	None	Possible	Yes	Yes
Penetration Aids	None	Possible	Yes	Yes
Doctrine	Minimal Deterrent	Minimal Deterrent	Minimal Deterrent	Limited Deterrent

[a]Ibid.

Table 5. Forecast of sea-borne strategic deterrent capability till 2040: present study.

Parameters	Current Forces	Stage 1: Minimal Deterrent (2020)	Stage 2: Minimal Deterrent overcoming BMD (2030)	Stage 3: Doctrinal Change (2040)
SSBNs	4 confirmed (5th may be operational)	5 (Type 094)	6 (5 Type 094 + 1 Type-096)	9 (4 Type-094 + 5 Type-096)
SLBM	12 nos. JL-2	12 nos. JL-2	12 JL-2/16 JL-3	12 JL-2/16 JL-3
Range (km)	7400	7400	7400/12,000	7400/12,000/ 14,000/ 16,000?
SSBNs on Patrol	1 (not continuously)	1	2 (1 Type-094 + 1 Type-096)	3 (1 Type-094 + 2 Type-096)
SLBMs deployed on Patrol	12	12	24–28	36–48
MIRVs	No (?)	Yes	Yes	Yes
Doctrine	Minimal Deterrent	Minimal Deterrent	Minimal Deterrent	Limited Deterrent

not alternative scenarios and represent the likely chronological development of strategic posture as China's SSBNs and SLBMs become more capable, coupled with the greater degree of sea control over its "extended bastion" in the South China Sea.

The parameters described in the table are (from top to bottom rows of first column): number of SSBNs; number of SLBMs carried by each submarine; range of the type of SLBM carried; the number of SSBNs planned to be on deterrent patrol at any given time; the number of SLBMs deployed at any given time (product of the number of SSBNs on the patrol and the number of SLBMs carried by each); the likelihood of MIRVs existing on the SLBMs deployed; and the governing nuclear doctrine that underpins this deployment pattern. The stages of development are elaborated further.

Forecast: year 2020

The second column of Table 5 indicates the current (as of 2019) reported values of the above parameters. Thus, there are four (or five) SSBNs in service, each carrying 12 JL-2 SLBMs (range 7400 km), which may not have MIRVs at present. Not even one Type-094 SSBN is presently on continuous deterrent patrol. As discussed earlier, in order to maintain one SSBN on continuous patrol, minimum four SSBNs need to be in service (with the others being in training, and under short/long maintenance). The present force levels and deployment pattern are in keeping with the "minimal deterrent" posture outlined by Haynes,[37] which emphasises second-strike capability with the intention to deter military aggression or nuclear attack. These parameters are likely to be unchanged till 2020 (the third column of Table 5), except that at least five SSBNs would be in service.

Forecast: type 096 characteristics

The predictions for the second stage (year 2030) are indicated in the fourth column of Table 5. The five Type 094 s would still be in service, and the first of the next-generation Type 096 SSBN is likely to have entered service. With a production rate of one SSBN delivery per year (concurrent with SSN construction) in the enhanced-capacity Bohai shipyard, if construction commences in the "early 2020s,"[38] the delivery of the first of Type 096 is unlikely to be before 2030, in the assessment of the author.

U.S. analysts predict that the Type 096 may be installed with 24 JL-3 SLBMs.[39] However, in this author's opinion, it is considered that the number would not be more than 16 per submarine. The U.S. *Ohio* class SSBNs have 24 SLBM launchers each, and its next-generation *Columbia*-class is to be fitted with 16 missile tubes. Even for the in-service *Ohio* class, four SLBM launch tubes for each boat are de-activated, in order to comply with strategic arms control limits, reducing the effective number of SLBMs to at most 20 per submarine.[40] The current UK SSBNs of the *Vanguard* class carry 16 SLBMs. The next-generation *Dreadnought*-class SSBNs of the UK will have 12 missile-launch tubes, but may carry only 8 SLBMs each. The latest *Borei*-class SSBNs (both Project 955 and 955A) of Russia have 16 SLBMs,[41] each with 6–10 MIRV warheads.

Thus, from the current payload of 12 SLBMs per Type-094 submarine, China is likely to increase to 16 and not 24 SLBMs each for the Type-096. The corresponding values are reflected in rows 3, 4 and 6 of the "Stage-2" column in Table 5.

This quantity of SLBMs would allow adequate destructive capability (particularly for a "minimal" deterrent) spread over a greater number of platforms, thus improving survivability. The large number of China's land-based missiles is another moderating factor. On the other hand, a greater number of MIRV-ed warheads are likely to be deployed, to ensure penetrability of the strike against BMD. That is the reason for "Stage 2 (year 2030)" in Table 5 being designated as "minimal deterrent overcoming BMD".

Forecast: number of SSBNs in 2030

What would be a reasonable number of SSBNs for China? Even in a dense missile defence environment (if the United States deploys its proposed 100-interceptor NMD system), China would want at least 50 warheads to survive a U.S. first strike in order to maintain confidence in its deterrent. This would require a total force of 100–200 missiles (including land-based missiles), or a somewhat smaller number of missiles equipped with MaRV/MIRV capability.[42] Considering that 75–100 ICBMs are already deployed,[43] at most 100 warheads would be required to be deployed at sea on SSBNs. Assuming at least four MIRVs per missile, this requirement can be met by deploying about 25 SLBMs at sea on patrol. Therefore, (as indicated in row 6 of Table 5) this requirement can be met by the year 2030 by having two SSBNs on patrol, each carrying 12/ 16 SLBMs.

Working backwards, in order to sustain two SSBNs continuously on patrol, a fleet of six SSBNs (row 2 of "Stage-2" column in Table 5) may be considered essential.

Forecast: number of SSBNs in 2040

The limited deterrent strategy[44] aims to deny victory to the opponent (as against the aim of deterring aggression of the minimum deterrent strategy). In addition to the force characteristics of the "minimal deterrent" strategy, the "limited deterrent" strategy envisages capabilities of advanced command and control and focused strikes on counter-leadership or industrial targets. It also envisages a force size large enough for graduated response. If, as expected, the Chinese military reaches a level of modernisation envisaged in the "China Dream,"[45] its strategic ambitions may also increase to maintain a "limited deterrent." In that scenario, three SSBNs simultaneously on patrol (row 5 of last column in Table 5) would represent 36–48 SLBMs (row 6) available for second-strike, translating to

150–200 warheads in case of MIRVs, which would be around double the number predicted for "Stage-2" (2030).

Working backwards again, to maintain three SSBNs on patrol, a fleet of nine SSBNs (row 2 of last column in Table 5) should suffice. These numbers are feasible to achieve by year 2040 as per construction capacity as well, with delivery of one SSBN every two years.

It is therefore difficult to justify China aiming for a fleet of more than nine or ten SSBNs based on its strategic requirements as well as "great power" imperatives.

Uncertainties in the forecast

Several questions can be raised on the assumptions and projections for the forecasts made in the paper. Some of these are highlighted (and where possible, justified) in this section.

Present strength

This paper has started by considering present (2019) SSBN force of confirmed four, and possibly five, operational *Type 094* SSBNs. High-frequency satellite imagery has suggested that at least five *Type 094*s are operational.[46] If one boat is considered to have been at sea, this would indicate a fleet strength of six (if not more) operational SSBNs even in end-2018.

However, the U.S. DoD Annual Report of 2019[47] suggests that although six *Type 094* have been built, four are operational and two are undergoing outfitting/ trials.

Accordingly, this paper has assumed that four or five SSBNs are operational as of 2019. If these present numbers are incremented by two, the forecasts presented here for 2020, 2030 and 2040 would be not be materially affected, since the reasoning is based on geographical necessity, doctrinal imperatives and operational philosophy, and not just on construction capacity.

Construction capacity

The capacity estimated at Bohai Shipyard, Huludao was quoted earlier as adequate to build two SSBNs and up to four SSNs simultaneously. With efficient pre-assembly module fabrication, this could enable two SSNs and one SSBN to be launched every year. Assuming these estimates are correct, and if they are utilised to full capacity, what would be the resultant force levels? Between 2019 and 2030, could 10–12 SSBNs (and 20–24 SSNs) be launched? Assuming a period of (at least) 4–5 years between launch and operational availability, 7–9 SSBNs could be inducted between 2019 and 2030, and possibly another 6–8 by 2040. At this pace of production, the number of SSBNs could reach 20–22 by 2040.

While China has repeatedly shown (since about 2000) the capacity to produce warships at rates considered hitherto impossible, there are a few considerations that make this scenario appear unlikely. First, the expansion of a shipyard should logically cater not only for envisaged requirements but also growth margins, both in terms of number of vessels and their dimensions. Hence, mere presence of facilities does not guarantee their simultaneous, immediate or complete usage.

Second, it may appear intuitively illogical to produce less than the maximum capacity, but peak production is not governed only by shipbuilding infrastructure. The availability of long-lead and complex equipment required for SSBNs have been challenging even for the most industrialised of developed nations.

Third, the shipbuilding infrastructure analysed by satellite imagery could well be utilised for scheduled maintenance and repairs also, for which demand will increase as fleet size increases.

Fourth, the production capacities assume a certain utilisation for each type of facility identified from satellite imagery, which superimposes assumptions on sequence of assembly/ construction, all of which may result in highly optimistic projections. The rate of outfitting and time taken in trials would not be possible to forecast based only on number of building bays and other visible features of the shipyard.

Due to the above arguments, it is considered that although submarine-building infrastructure capacity may indicate greater numbers, the rationale behind the force levels suggests a lesser number of perhaps six SSBNs by 2030 and nine SSBNs by 2040, as indicated in Table 5.

Linkage between SSN and SSBN numbers

It is implicit that the production of SSNs would have an impact on any SSBN construction programme. Many major equipments including the power plant, would possibly originate from the same set of manufacturers. Production facilities would also be shared and emphasis on one would impact the progress of the other.

Predictions in Table 3 suggest roughly equal numbers of SSBNs and SSNs (12 each) by 2030. The prediction of the current study is smaller, of about 6 SSBNs by 2030. What would be the likely corresponding number of SSNs in 2030?

The roles and utilisation of SSNs are beyond the scope of the present paper. Suffice to say that a major role for SSNs is to escort and sanitise the approaches for SSBN to its patrol areas. This study has concluded that the "extended bastion" approach in the South China Sea would be the most likely for Chinese SSBNs. Accordingly, it would be logical to have at least the same number of SSNs in service as the SSBN fleet. However, in addition, SSNs would be expected to operate in tandem with the rest of the fleet as well. It may be reasonable to consider a similar number of SSNs for such additional tasking. Thus, for a force of six SSBNs, six SSNs could be planned for SSBN escort roles and another six SSNs for fleet deployments. Thus, the estimates of Erickson quoted in Table 3 for SSNs may be underestimated and the SSBN forecast in Table 5, in this author's view, would correspond to a larger force of around 12 SSNs. This is more likely from viewpoint of operational requirements and as feasible in terms of construction capacity as well.

ASW effectiveness and SSBN patrols

One of the premises for projected force levels based on requirements is that two SSBNs should be on patrol at any given time. This is justified considering "50% effective" ASW, which is a crude way of saying that one in two boats on patrol could get detected by enemy surveillance, and hence compromised for reliable second-strike in case of hostilities. This assumption is difficult to justify, and may be unfounded, but then it would not justify the steady growth of the Chinese SSBN programme observed, and a total of only four to five SSBNs could suffice.

The number of SSBNs required for "Continuous At Sea Deterrence" (CASD) has been debated by every nation operating SSBNs. With a fleet of just four SSBNs, both France and UK have been able to maintain CASD for decades now. To maintain two boats on patrol, there would be at least two (or one) more on short maintenance, one in long maintenance and one (or two) under trials/ training, adding up to a requirement of six boats.

Similarly, in case three boats are to remain on patrol at any given time, the total requirement is estimated to be 8–9 boats (3 on patrol, 2 in short maintenance, 2 in long maintenance and one or two in trials/training). It may be noted that a larger fleet size and frequent inductions could lead to near-simultaneous scheduling of maintenance periods, which could be counter-productive. These projections fit in with the forecasts made in Table 5.

China's future SSBN fleet: smaller than predicted?

The strategic goals for Chinese build-up of its SSBN fleet and SLBM capabilities are, to a large extent, a matter of conjecture. This study has highlighted the link between geographical constraints faced by China in SSBN deployment, and China's resolute actions to gain control of the South China Sea and its islands. The expansion of the Chinese fleet of warships, spearheaded by its Aircraft Carrier programme is also linked to strengthening sea control in the South China Sea and thus enhancing survivability of its SSBNs.

Based on analysis of China's nuclear strategy and likely SSBN deployment pattern, this study has predicted the contours of the future Chinese SSBN force, and the main platform characteristics of its next-generation SSBN. A force of five to six SSBNs may suffice from the viewpoint of "minimum deterrence," but this assumes the development of JL-3 SLBMs with the range of at least 12,000 km (and maybe as high as 14,000–16,000 km), so that mainland U.S. is targetable from the "extended bastion" of the South China Sea off Hainan.

If China aims, in the longer term, to deploy SSBNs in the Western Pacific (by overcoming barrier ASW efforts likely at choke points), there would be a case for a larger fleet of nine SSBNs by year 2040.

While these predictions are lower than those in other published studies, the assumptions and considerations for the forecasts have been provided and uncertainties highlighted. It is considered that although actual numbers may remain difficult to confirm, the Chinese SSBN programme may not be as ambitious as widely surmised. If the underlying drivers for the programme prove to have been realistically assessed, it would promote confidence and reinforce the credibility and stability of deterrence in the Indo-Pacific region.

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