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MATSYA JAALA: THE UPRISING OF UNDERWATER WARFARE

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Abstract

The underwater domain has evolved from a tactical arena for sea denial into a strategic theatre for deterrence and Grey Zone warfare. This article is an attempt to contextualise the historical trajectory of submersibles. It also analyses the Indian Navy's strategic transition towards sea control via its developing nuclear triad. It critically scrutinises the capabilities of the Arihant class SSBNs and Kalvari class against inherent environmental and acoustic challenges. Significant emphasis is placed on technological asymmetries vis-à-vis adversaries, particularly the absence of Air Independent Propulsion (AIP) and operational nuclear-powered attack submarines (SSNs). Furthermore, the study examines indigenous design constraints, such as the hydrodynamic Turtleback penalty and reactor power density limitations. It concludes by advocating for the acceleration of Project 75(I) and the establishment of a Seabed Warfare command to secure future maritime dominance.

Introduction

In the last few decades, the underwater domain, the one beneath those “milky waves”, has seen a major transformation warfare which is fought from its traditional role of sea denial to that of becoming strategic deterrence. There is no overstatement when one talks about the relevance of underwater warfare domain. These range from nuclear-powered ballistic missile submarines (SSBNs) to the latest generation of Extra-Large Unmanned Underwater Vehicles (XLUUVs). This article is an attempt to address the strategic importance of these UUVs.

The surface assets are increasingly vulnerable to anti-ship missiles and satellite surveillance. But the ‘opaque’ medium of the ocean offers a natural layer of protection to these assets. This helps ensure that the critical maritime domain is supplied with an extra dose of deterrence from underneath. However, the strategic importance of this domain has expanded beyond the earlier-mentioned assets. We are now in an era that is witnessing an unprecedented rise of "Grey Zone Warfare”. This is where the seabed itself is a frontline. Approximately, a staggering 95% of *international data traffic* flows through undersea fibre-optic cables.[1] There is also a growing network of *energy pipelines* traversing the ocean floor. Thus, an ability to efficiently monitor, tap, or sever these links offers nations a potent lever of coercion. The "*Indian Maritime Doctrine 2025*" formally recognises this "*no-war, no-peace*" state as a distinct operational category.[2] Thus, there is a need for persistent underwater surveillance.

The underwater warfare system domain is expected to grow significantly. Integration with Artificial Intelligence (AI), other advanced technologies, and material science is complementing this rise. There is a visible shift in naval strategy from platform-centric operations, which relied on a few expensive submarines to network-centric operations. Their operation depend upon arrays of interconnected sensors and drones which are critical for such warfare. It can be said that “whoever controls the transparent ocean with a solid grip on the opaque one that is underneath will dominate the maritime order of the future”.

The Timeline of the Opaque Domain

This section is an attempt to show a few important milestones that have helped shape the domains of Underwater Warfare.

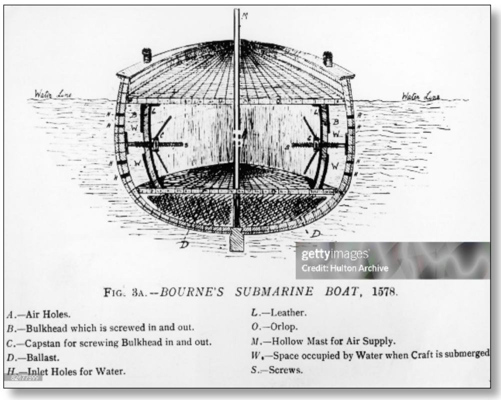


Image: Bourne’s Submarine boat)

1578 - The Theoretical Beginnings: A British mathematician named *William Bourne* drafts the first theoretical design for a submersible craft.[3] He hoped for an enclosed boat that could be rowed underwater. Thus, there was a groundwork laid for the future.

1776: The Turtle's Debut: During the American Revolutionary War, David Bushnell’s Turtle attempted the first submarine attack on a warship, the *HMS Eagle*.[4] It was unsuccessful but highlighted the importance of the underwater approach.

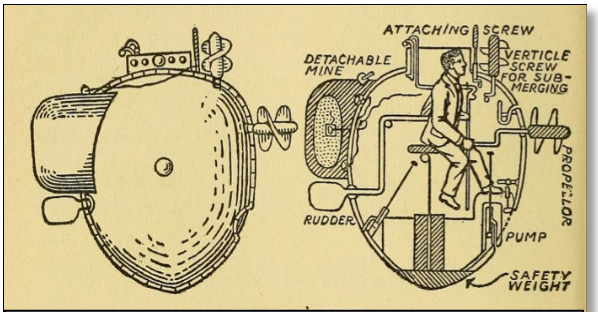
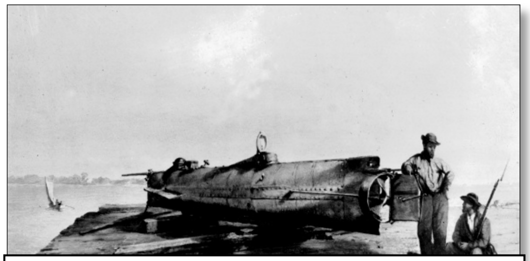


Image: Bushnell’s Turtle
(Source: Connecticut History)

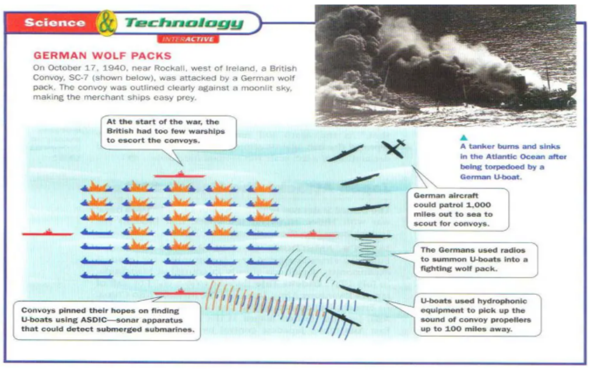
1864: First Successful Sinking: The Confederate submarine *H.L.Hunley* became the first submarine in history to successfully sink an enemy ship.[5] It sank the USS Housatonic. This was during the American Civil War.



(Image: H.L.Hunley submarine)
(Source: LinkedIN)

1914 - 1918: The U-Boat Terror (WWI): There is a mass-scale operationalisation of the *Unterseeboot* (U-boat) by Germany. Submarines became the capital weapons when *SM U-9* sank three British cruisers in under an hour.[6] Germany's unrestricted submarine warfare campaign nearly sank over 5,000 Allied ships.[7]

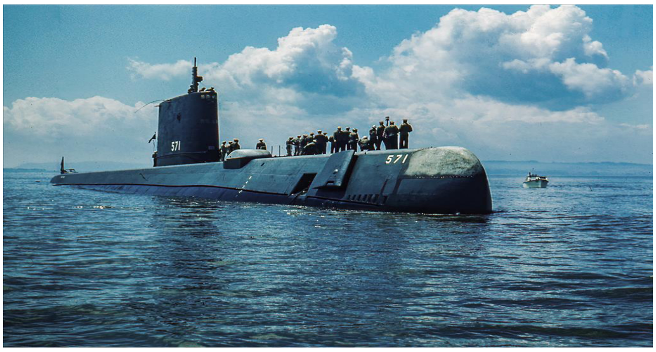
Image: The U – 9 Submarine)
Source: Today I found Out)



(Image: The Wolf Pack Attack)
(Source: War History)

1940–1945: Wolf Packs & Silent Service (WWII): The "*Wolf Pack*" tactics by Admiral Dönitz, coordinated via radio was a notable moment in submarine warfare.[8] Also were the US submarines in the Pacific that crippled the Japanese merchant marine.

1954: The Nuclear Revolution: The launch of *USS Nautilus (SSN-571)* revolutionised naval warfare.[9] 'Nuclear power' frees the submarines from their need to surface for air. This allowed for 'theoretically infinite submerged endurance'. The only limitation was of supplies and the crew.



(Image: USS Nautilus)
(Source: HistoryLink)

(Images: Polaris Launch)

1960: The Age of Deterrence: The first submerged launch of a Polaris ballistic missile was conducted by *USS George Washington*.[10] This is an official entry into the era of SSBN.

1982: Falklands War: The only instance of a nuclear-powered submarine sinking an enemy surface ship in combat. This was the Royal Navy's *HMS Conqueror* sinking the Argentine cruiser *General Belgrano*.[11] It demonstrates the sheer lethality of modern SSNs.

(Image: General Belgrano sank by HMS Conqurer)

(Image: US UUV)
(Source: Centre for International Maritime Studies)

2016: A US Navy Unmanned Underwater Vehicle (UUV) in the South China Sea was seized by a Chinese naval vessel.[12] This marked the first major geopolitical friction point involving unmanned systems. Thus was the start of the "drone era" in underwater warfare. The advancements in more such Autonomous warfare i.e., UUAVs and XUUVs, are discussed in detail in subsequent sections.

The Indian Armada

India's underwater strategy is evolving from that of a defensive sea denial posture to a more assertive strategy of sea control in the Indian Ocean Region (IOR). It is effectively complemented by credible minimum deterrence through a nuclear triad.

The Nuclear Triad

The crown jewel of India's underwater capability is its Ship Submersible Ballistic Nuclear (SSBN) program.

Feature	**INS Arihant (S2)**	**INS Arighat (S3)**
Commissioned	2016	2024
Status	Active	Active

Displacement (Submerged)	~6,000 tonnes	~6,000 tonnes
Length	110 - 112 m	111.6 m
Propulsion	83 MW PWR	83 MW PWR
Max Speed (Submerged)	24 knots	24 knots
Missile Range	750 km (K-15)	750 km (K-15)
	3,500 km (K-4)	3,500 km (K-4)
Crew	95 - 100	95 - 100

(**Table:** Features of INS Arihant and INS Arighat), (**Source:** Author's Compilation)

The successful testing of the K-4 Submarine Launched Ballistic Missile (SLBM) with an impressive range of about 3500 km has given these platforms the ability to strike deep into the adversary's territory.

Conventional Hunter-Killers (SSKs)

- **Project 75 (Kalvari Class):** This program is nearing completion with the 6th submarine, *INS Vagsheer*. These Scorpene-class boats are equipped with Exocet anti-ship missiles and advanced sonar.

Parameter	Details
Type	Diesel-Electric Attack Submarine (SSK)
Crew Capacity	25 to 31 (+14 combat divers)
Length	67 meters (~ 220 ft)
Beam (Width)	6.2 meters (20 ft)
Displacement	Surfaced: 1,615 tonnes Submerged: 1,775 tonnes
Motor	Permanent Magnet Synchronous Motor
Batteries	360 Battery Cells (High-power lead-acid)

Max Speed	Surfaced: 11 knots (20 km/h) Submerged: 20 knots (37 km/h)
Diving Depth	> 350 meters (1,150 ft)
Endurance	~50 days at sea
Range	Surfaced: 6,500 nmi at 8 knots Submerged: 550 nmi at 4 knots
Stealth Tech	Advanced acoustic silencing, low radiated noise levels, hydrodynamically optimized shape

(Table: Features of P75 Scorpene Class Submarines) (**Source:** Author's compilation)

Unmanned Systems

In November 2025, the DRDO unveiled the Fully Autonomous Man-Portable Autonomous Underwater Vehicle. It is developed by the Naval Science and Technological Laboratory (NSTL). It is an AI-driven drone capable of detecting mines and conducting surveillance. It involves minimal human risk.

Parameter	**Specification / Details**
Type	Autonomous Underwater Vehicle (AUV)
Portability	Deployment by 1-2 personnel (Shore, RIBs, or small craft)
Weight	< 50 kg
Hull Material	Non-magnetic composite (helps avoid magnetic mines being triggered)
Form Factor	Hydrodynamic cylindrical body (offers high stability and low drag)
Power Source	High-density Rechargeable Li-ion Battery
Propulsion	Electric Thrusters (They have a low acoustic signature)

Endurance	Optimised according to mission cycles (several hours)
Primary Sensor	Side Scan Sonar (SSS). It offers high-res seabed mapping and object detection
Visual Sensor	Electro-Optical Underwater Cameras
Processing	Edge Computing that offers real-time data analysis
Target Recognition	Automatic Target Recognition (ATR) to distinguish mines from clutter using deep learning and AI algorithms.
Networking	An acoustic communication system that enables the Swarm capability.
Role	Mine Countermeasures (Mine Hunting)

(Table: Autonomous Man-Portable Autonomous Underwater Vehicle DRDO Features) (**Source:** Author's Compilation)

Challenges Associated with Underwater Warfare

The underwater environment presents unique challenges that often do not exist in conventional domains such as land, air and surface. Some of these are presented in this section.

- **The Communication:** Radio waves are absorbed almost instantly by water. Therefore, the submerged vehicles depend on SONAR. This leads to the creation of massive latency as sound travels at roughly 1,500 m/s (about 200,000 times slower than light)
- **Bandwidth Constraints:** Transmitting a high-res image from a drone to a submarine can take minutes as the acoustic modems have incredibly low bandwidth (often in bits per second. This makes the real-time video feeds almost impossible.
- **Environmental Interference:** The signals can get distorted or blocked entirely because of salinity, temperature layer and ambient noise caused by shipping traffic, marine life and such. Nuclear submarines produce loud noises, they are huge, and costly.

- Submarine and UUV operate using batteries. The Li-ion batteries which are considered advanced, do suffer from low energy density in comparison to those of diesel fuel. To recharge, they must bring the diesel engines near to the surface. This puts them at risk of being detected by radars.
- Air Independent Propulsion is a complex domain. It is costly to retrofit. There is a need for cutting the submarine hull in half. While operating at depths of more than 300 meters there is a risk of hulls being exposed to extremely high pressures. This will eventually tamper with their performance.
- There is requirement of high-tensile steel or titanium while manufacturing the hulls. There is a need for specialised, oxygen-free environment. This becomes a necessity in order to prevent ensure microscopic cracking. This is possessed by a handful of shipyards globally.

India: Strategic Challenges, Gaps, and The Way Forward

While India is a formidable maritime power, a realistic assessment reveals significant gaps when compared with its global counterparts and adversaries like China. This section mentions a few challenges that India is experiencing in its Underwater Capacity Expansion.

- The Indian Navy has an authorised submarine strength of 24. But the operational availability is only 19.[13] The older hulls are retiring. This creates a risk of the fleet shrinkage.
- While Pakistani forces operate the AIP-equipped submarines (Agosta 90B), India's Kalvari class do not have this capability.[14] Hence there is a risk of tactical disadvantage. This is particularly in terms of endurance capability.
- There are no Nuclear-Powered Attack Submarines (SSNs) that are operational in India.[15] These are necessary to ensure that one possesses high-speed intercept capability. The slow diesel subs are not capable to chase a carrier that move at high speeds.
- There is a lack of a deployed fleet of underwater drones or a seabed warfare ship those are combat-ready in India. This puts the underwater cables under threat. They become vulnerable to various threats.

- The Pressurised Water Reactor (PWR) uses a less enriched uranium. This is often as less as 40%.[16] When compared with 93 to 97% weapons-grade enrichment in US/UK naval reactors this is critically lower. This kind of low enrichments leads to lower power density.[17]
- It is critical to generate more than 220 MW of power. This is important to propel a massive 18,000 tonne submarine. Simultaneously the speed factor also is not to be compromised. To make this feasible and achievable, there is a need for a much larger reactor core. This in turn requires a wider hull. The reactor therefore often kept compact and small.
- The US/UK submarine reactors use cores that last more than 30 years without the need for refuelling. The *Arihant* reactor requires a more frequent refuelling. This is possible only when the hull is cut open. This then puts the submarines out of service for a significant amount of time.
- The long-range missiles are normally more than 12 meters tall. These are often taller than the hull's depth. Thus, they protrude above the top. This necessitates for a raised casing or hump known as a 'Turtleback'. This creates disruptions in the laminar flow of water over the hull. There is a generation of flow noise (turbulence and vortex shedding) at greater speeds. Thus the system eventually becomes exposed to the enemy sonar.
- **Design limitations:** *Arihant* class submarines deploy a highly skewed seven bladed propeller. These are no doubt advanced but suffer from complexity related to the structural design.
- **Steel Grade:** *Arihant* is built using Russian-equivalent high-tensile steel. These no doubt are strong, the modern deep-diving submarines use superior grades of titanium alloys. The use of older-generation steel often restricts the test depth (maximum safe depth). A shallower crush offers less vertical room to hide from surface sonar. Also, there is a lesser margin for error during evasive manoeuvres.
- **Passive Array Size:** The size matters in underwater detection. The sensitivity of a sonar array is directly proportional to its physical size (i.e., aperture). The *Arihant's* small bow section puts limitations on the size of the spherical sonar

array it can carry. Larger boats like the US *Ohio* or Russian *Severodvinsk* carry massive bow arrays and long flank arrays. This gives them a detection range advantage of dozens of kilometres.

Addressing the Gaps: Active Measures in Action

- The long-stalled Project 75(I) is finally moving. The deal with Germany's ThyssenKrupp Marine Systems (TKMS) is crucial. This is a project with an estimated ₹70,000 crore worth.[18] It will deliver six advanced submarines that will be equipped with Fuel-Cell AIP. This is quieter and more efficient than the competitor systems. There is a full Transfer of Technology (ToT) involved.
- The Cabinet Committee on Security has cleared Project 77 for the indigenous construction of two SSNs. This is estimated at ₹40,000 crore.[19] It is a vital long-term fix for the speed and endurance gap.

What More Needs to Be Done?

- The cycle from approval to induction in India is very slow (10–15 years). Agility must be prioritised to bring Project 76 and Project 77 to fruition before 2032.
- India needs to raise a specialised Seabed Warfare command. This could involve the acquisition of dedicated ocean surveillance ships and deep-sea rescue vehicles (DSRVs) that are capable of offensive and defensive cable operations.
- India could expand its fleet of P-8I Poseidon aircraft and Sea Guardian drones. This could ensure that no enemy submarine can enter the Malacca Strait undetected. A continuous acoustic fence across the Andaman Sea is now an absolute strategic necessity.

Conclusion

The evolution of underwater warfare has for sure has transformed from its traditional role of sea denial to that of a decisive theatre for strategic deterrence. This complements the preservation of critical infrastructure in the Grey Zone. While the commissioning of platforms like INS Arihant and INS Arighat signals India's definitive transition toward a credible nuclear triad, the strategic imperative now lies in overcoming the inherent design limitations, such as the Turtleback problem and the persistent void of the SSNs. The nation needs to urgently accelerate Project 75(I) and the indigenous construction of SSNs to bridge the technological asymmetry with its counterparts and adversaries. Ultimately, the mastery of Matsya Jaala is not merely about accumulating hulls, but about realising that whoever commands the transparent ocean above must maintain a stronger control on the opaque one beneath it. This would help dictate the future maritime order.

DISCALIMER

The paper is the author's individual scholastic articulation and does not necessarily reflect the views of CENJOWS, the Defence forces, or the Government of India. The author certifies that the article is original in content, unpublished, and it has not been submitted for publication/ web upload elsewhere, and that the facts and figures quoted are duly referenced, as needed and are believed to be correct.

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