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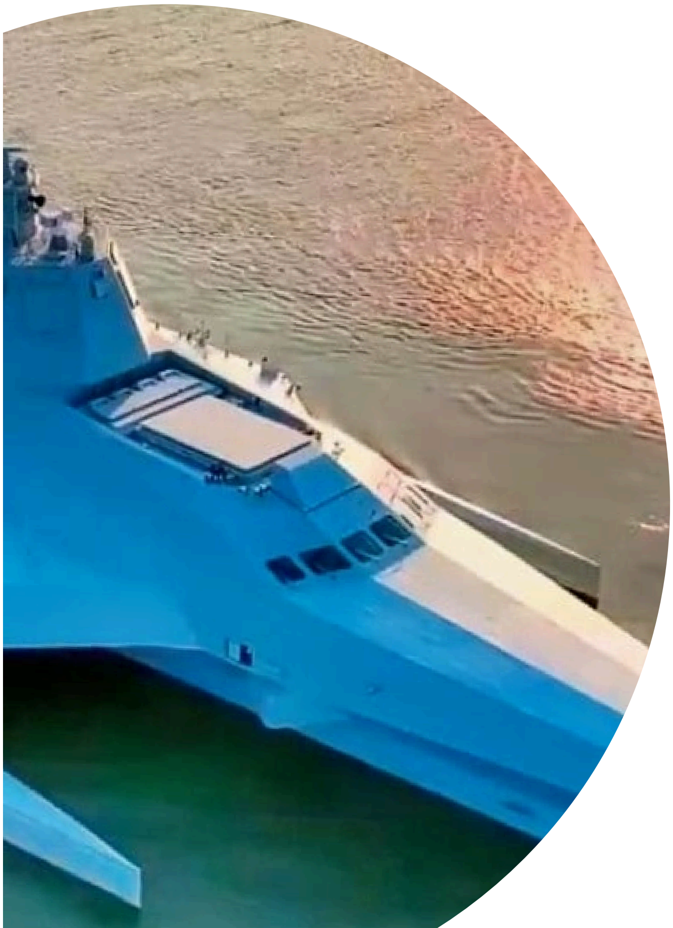

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July 17, 2025
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Executive Summary

China is accelerating the integration of artificial intelligence (AI), autonomous systems, and intelligent command networks across its naval and surveillance infrastructure in the South China Sea. Through technologies such as seabed sensors, AI-enabled unmanned vehicles, and real-time data fusion, Beijing is building a maritime system designed to compress decision time, detect stealth platforms, and assert persistent presence in contested waters. Such developments challenge U.S. maritime awareness and undermine the foundations of regional deterrence.

This paper assesses China's integration of autonomous vehicles (AVs), advanced sensor networks, and AI-enabled command-and-control (C2) systems to enable persistent maritime domain awareness and expand gray-zone operations in the South China Sea. These next-generation capabilities are reshaping the strategic environment by compressing decision cycles and challenging U.S. surveillance dominance. While the United States is advancing in Intelligence, Reconnaissance, and Surveillance (ISR) modernization, unmanned platforms, and multi-domain C2, it is constrained by its geography and its limited regional basing in the SCS.

To maintain maritime advantage, the United States must accelerate development of autonomous platforms, advanced sensing, and AI-enabled C2 by deepening ties with the commercial sector. Yet even the most sophisticated systems are vulnerable to disruption without robust cyber defense and safeguards against adversarial AI. The decisive factor will be informational dominance rather than technological parity. AUKUS Pillar II provides the architecture for a fused multinational surveillance and decision-making network. Integrating allied ISR, command systems, and sensor data streams is essential to offset China's geographic advantage and preserve decision superiority in the South China Sea.

The South China Sea Dispute

The South China Sea dispute (SCS) is defined by overlapping territorial claims and contested interpretations of maritime law, with China's expansive "9-Dash Line" encroaching on the exclusive economic zones (EEZs) of the Philippines, Vietnam, Malaysia, and others.[i] Beijing's rejection of the 2016 UNCLOS arbitration ruling, combined with its militarization of artificial islands and use of maritime law enforcement to pressure and harass regional adversaries, reflects a deliberate strategy to consolidate strategic depth and reshape regional norms. Such actions are embedded in China's broader effort to assert regional primacy and undermine the credibility of U.S. security commitments in the Indo-Pacific.

The United States retains vital national interests in the region, including defense treaty obligations to the Philippines, access to key sea lines of communication, and the maintenance of a credible deterrence posture toward Taiwan.[ii] In recent years, Washington has expanded joint naval operations with Japan and Australia, deepened security coordination with the Philippines under the Enhanced Defense Cooperation Agreement (EDCA) and signaled closer alignment with Taiwan through arms sales and high-level engagement.[iii] Allies within the AUKUS agreement–Australia, the United Kingdom, and the United States–have increased coordination and operational presence in support of a free and open Indo-Pacific, complemented by growing engagement from partners such as France and Japan.

The South China Sea has become the forefront domain for U.S.-China strategic competition: testing alliance credibility, escalation risk, and regional order.

China's Naval Expansion and Modernization

While Deng Xiaoping promoted a restrained, economically focused foreign policy, Xi Jinping has elevated the PLA Navy (PLAN) as a central instrument of China's rise. Since 2012, Xi's leadership has framed maritime power as essential to securing China's national rejuvenation and contesting U.S. influence in the Indo-Pacific.[iv] This strategic reorientation has reshaped China's naval posture from near-seas defense to open-ocean presence.

China's pursuit of a blue-water navy is anchored in its unprecedented shipbuilding capacity. As of 2024, the PLAN maintains the world's largest fleet by hull count, with over 370 warships.[v] This includes advanced destroyers (Type 052D/055), stealthy diesel-electric and nuclear submarines, and multiple domestically produced aircraft carriers. Much of this growth stems from the state's ability to mobilize resources through state-owned shipyards and defense-industrial integration. Analysts note that China's production timelines significantly outpace U.S. naval procurement, allowing for faster fleet expansion and platform iteration.[vi]

In parallel with hardware expansion, China has emphasized the development of advanced maritime domain awareness (MDA) and distributed maritime operations (DMO). These efforts are designed to fuse sensor networks, overhead ISR assets, and command platforms into a real-time operational picture. MDA serves as a foundation for China's anti-access/area denial (A2/AD) strategy, which seeks to degrade or delay U.S. power projection through long-range precision strike systems and persistent surveillance in contested waters, particularly in the South China Sea.[vii]

The next phase of PLAN modernization will prioritize the integration of emerging technologies– specifically advanced sensors, unmanned and autonomous vehicles, and deep-learning powered processing systems for automated command and control.

PLAN Next-Generation Technology Integration and Strategic Implications

China's maritime modernization increasingly hinges on the integration of next-generation technologies that enhance sensing, mobility, and decision-making across contested domains. Central to this effort are advancements in seabed sensor networks, autonomous naval platforms, and AI-enabled command and control systems. These technologies carry broad strategic implications for both China and the United States, shaping future dynamics of deterrence, escalation management, and maritime power projection in the Indo-Pacific.

Sensors and the Great Underwater Wall

China is rapidly operationalizing an advanced undersea surveillance system in the (SCS, centered on what has been termed the "Underwater Great Wall" (UGW). First unveiled by the China State Shipbuilding Corporation (CSSC) in 2015, the project combines seabed hydrophone arrays, autonomous vehicles, acoustic buoys, and fiber-optic relays to provide continuous undersea monitoring and surveillance of strategic chokepoints across the SCS.[viii] The system integrates with PLA Navy (PLAN) command centers on Hainan and militarized outposts such as Fiery Cross and Mischief Reef to create a real-time ISR network designed for anti-submarine warfare (ASW) and MDA. [ix]

The UGW, developed as an advanced form of the Soviet Union's Sound Surveillance System (SOSUS), serves as a dual system for oceanographic research, disaster monitoring and maritime surveillance.[x] It supports China's broader goal of intelligentized warfare by creating "Blue Ocean Information Network" capable of persistent maritime awareness. Since its launch in 2015, the project has successfully operationalized at least two deep-sea acoustic sensor arrays, one in the Mariana Trench and another near the island of Yap.[xi] Such listening posts have impressive range – reportedly picking up acoustic signatures beyond the First Island Chain and as far away as the U.S. naval base Guam.[xii]

The UGW integrates next generation sensing technologies, particularly edge AI, quantum sensing, and multi-domain data processing, to enable continuous and intelligent domain awareness.[xiii] Edge AI refers to the semi-autonomous processing of sensor data directly at collection point, such as seabed nodes or unmanned vehicles, to enable immediate analysis and anomaly detection.[xiv] By reducing reliance on human operators, Edge AI minimizes latency and improves anomaly detection accuracy in complex or noisy conditions. Its capabilities will be further enhanced by the development of photonic chips, which, as demonstrated by Tsinghua University, integrate sensing and computation in a single device for nanosecond-scale data processing at the sensor node.[xv]

China is further advancing in quantum sensing technologies, particularly magnetometers and gravimeters, that detect subtle magnetic and gravitational anomalies produced by submarines and other underwater assets as a complement to traditional sensors and AI-enabled detection.[xvi] Quantum sensors, with the help of China's Military-Civilian Fusion strategy, have rapidly developed and begun to be integrated within unmanned underwater vehicles. Chinese research suggests that such sensors are sensitive enough to detect the magnetic wake of U.S. Seawolf-class submarines in near-shore, littoral conditions.[xvii]

China's deployment of AI-enabled seabed sensors and quantum surveillance in SCS directly challenges U.S. maritime awareness dominance. By detecting and tracking submarines near chokepoints, the UGW counters the stealth measures of SSN's (Ship, Submersible, Nuclear) and SSBN (Ship, Submersible, Ballistic Nuclear) – critical assets for U.S. deterrence strategy.[xviii] Regionally, persistent monitoring enables China to project its presence and enforce maritime claims in disputed waters in the SCS. By framing the surveillance system as dual-use, supporting scientific and security funcitons, China legitimizes their territorial claims while employing gray zone operations such as persistent monitoring and pressure on rival maritime actors without triggering direct escalation.

Unmanned Autonomous Vehicles

In addition to an advanced sensor surveillance system, China's deployment of next-generation autonomous vehicles (AV's) is a central component of their maritime strategy and gray-zone operations. Such platforms extend China's maritime domain awareness range, project an active presence in contested territories, and enable rapid decision-making in the SCS. The level of autonomy of such vehicles varies widely across systems – influencing their responsiveness, operational control, and military capabilities. For the purpose of this policy paper, an autonomous vehicle is framed using a definition from the National Research Council as an "unmanned vehicle with some level of autonomy built in–from teleoperations to fully intelligent systems." [xix]

Table 1 provides an overview of several Chinese AV platforms, organized by role, deployment, and technological capabilities. Several capabilities warrant attention. First, swarm coordination, as demonstrated by systems like the Yunzhou L30 "Watcher" and the JARI USV, allows multiple vessels to cooperate in tracking targets, blocking transits, or overwhelming defenses through coordinated maneuvers to jam and saturate senor and response systems.[xx] Such swarm tactics rely on AI systems that process data in real time, allowing for automated trajectory adjustments for precise coordination. Such spatial awareness is further supported by AI-enabled navigation and obstacle avoidance systems which allow AVs to operate in contested and complex environments and avoid maritime traffic with minimal human input.[xxi] Furthermore, AV's serve as mobile sensory nodes within the Great Underwater Wall system, carrying electro-optical/infared (EO/IR), radar, and sonar sensors.[xxii] Lastly, autonomous targeting and engagement systems reduce human decision time and may eventually permit semi-automated strikes or intercepts, especially in future armed variants.[xxiii]

The strategic implications of China's autonomous maritime systems are significant for U.S. policy in the South China Sea. Despite the technological ambition reflected in their AV platforms, it remains difficult to assess their true operational capacity, particularly their wartime reliability, weapons integration, and resilience under adversarial conditions. In the meantime, China's military observers have taken clear lessons from recent conflicts, including Ukraine's 2025 "Operation Spider's Web" drone attack against Russian airbases.[xxiv] The strike, executed with smuggled drones and minimal infrastructure, closely studied in Chinese military journals as a model of asymmetric warfare and information-centric tactics. Analysts concluded that the attack validated China's existing emphasis on "informatized local wars," reinforcing its push for AI-enabled surveillance, autonomous targeting, and coordinated drone swarms for future conflict scenarios, especially across the Taiwan Strait.

More immediately, unmanned surface and underwater vehicles play a growing role in China's gray-zone operations. Autonomous systems allow China to assert control in disputed areas with lower risk of escalation. For example, in 2024, a Chinese USV rammed a Philippine supply ship near Second Thomas Shoal, disabling the vessel's steering.[xxv] The incident drew international criticism, yet failed to trigger a military response, demonstrating how unmanned tools offer plausible deniability and strategic ambiguity. With persistent ISR from unmanned patrols and a growing portfolio of semi-autonomous systems, China is testing red lines and expanding its operational space below the threshold of open conflict.

AI-Driven Command and Control (C2) and Data Fusion

The PLA's push toward an "intelligentized" and fully integrated C2 system reflects a broader CCP directive to modernize warfighting through automation, information dominance, and joint operational coordination. Since the 19th Party Congress, official doctrine has emphasized the development of a unified "strategic command brain" capable of fusing ISR data, controlling unmanned systems, and accelerating the decision cycle across maritime, air, and space domains.[xxvi] While the exact architecture of China's naval C2 infrastructure remains opaque, its intended function is clear: to enable real-time sensor-to-shooter integration, automate elements of the kill chain, and support distributed operations through AI-enabled decision support.

By linking edge devices, sensor arrays, autonomous platforms, and overhead ISR to command nodes, the system would generate a continuous operational picture – enabling faster anticipation, adaptation, and response in dynamic maritime environments. Driven by a central "command information system" described by Chinese engineers as the "brain" of intelligent warfare – fusing multiple sensory inputs into autonomous weapon systems. Such data fusion is the crux of this architecture, particularly integrating data from land, air, space, and cyber domains for automated decision-making. Yet, the scale of such data remains a major technical hurdle as Chinese researchers have recognized that data inconsistency, excessive redundancy and real-time responsiveness have degraded the coherence of the intelligent C2 system.[xxvii] To address this, China has begun developing a layered data fusion network that filters and integrates raw inputs for streamlined and real-time targeting cues that require minimal human intervention.[xxviii] A recent PLAN vessel reportedly achieved a 60% increase in command information processing efficiency through upgraded onboard systems, signaling concrete progress in closing the loop between sensor inputs and operational decision-making.[xxix]

If China succeeds in operationalizing its intelligentized C2 architecture, the United States risks losing its long-held advantage in adaptive decision-making and operational tempo. A fully integrated, AI-supported command network would allow the PLA Navy to compress kill chains, coordinate unmanned systems at scale, and outpace U.S. responses in a crisis.

Yet, the operational value of China's intelligentized C2 network hinges on its ability to withstand interference, manipulation, and degradation under contested conditions. As the PLA increases reliance on AI-driven decision systems, the integrity and security of its command architecture become critical vulnerabilities. Cybersecurity risks – particularly in satellite uplinks, edge-device firmware, and cross-domain data transfers – pose significant threats to system coherence. Moreover, U.S. and allied forces are likely to target these networks with cyber intrusion, electronic warfare, and AI-enabled deception campaigns. Chinese military researchers have already acknowledged the importance of building resilient decision chains and deploying AI capable of recognizing and responding to adversarial manipulation.

U.S Technological Posture in Maritime Security and Surveillance

While Chinese advances in autonomous platforms and intelligentized C2 systems have drawn significant attention, the United States continues to develop and deploy next-generation technologies for maritime surveillance and security. However, detailed information on U.S. capabilities – particularly in autonomous underwater vehicles (AUVs), data fusion systems, and AI-enabled ISR platforms – remains largely classified or restricted. As a result, this paper does not attempt to compare operational performance between U.S. and Chinese systems. Instead, it outlines the strategic direction of U.S. development in key domains relevant to Indo-Pacific maritime competition.

The U.S. is upgrading its maritime sensor architecture by integrating edge AI, machine learning, and cloud computing into their past sensory platforms such as the Integrated Undersea Surveillance System (IUSS) hydrophone network[xxx]. While no open-source evidence confirms U.S. advances in quantum sensing or photonic chip integration, the modernization of seabed arrays, towed sonar systems, and mobile sensors, alongside allied deployments, gives the U.S. global ISR reach, with strong indications of surveillance presence around, though not necessarily within, the South China Sea. In the autonomous systems domain, U.S. unmanned surface and underwater vehicles, such as Sea Hunter, Saildrone, and Orca XLUUV, have demonstrated long-range endurance, acoustic sensing, and coordinated operations using systems like ABL navigation and limited swarm capability[xxxi]. On the C2 side, the U.S. is developing the Multi-Domain Uncrewed Secure Integrated Communication (MUSIC) architecture to link unmanned platforms across services, though its operational effectiveness remains unclear[xxxii]. Unlike China's vertically integrated C2 model, which consolidates data through domestic assets and centralized command, U.S. maritime awareness relies on multinational ISR collaboration and shared infrastructure. This coalition-based model enables broader surveillance coverage but introduces additional complexity in fusing and operationalizing data across platforms and partners.

Policy Recommendations and Implications

China's accelerating integration of AI, autonomous systems, and maritime surveillance infrastructure demands deliberate policy responses from U.S. policymakers to preserve maritime awareness and information dominance in the Indo-Pacific. China is actively testing these technologies in the South China Sea, where escalation control, real-time sensing, and secure command networks will shape future conflict dynamics. U.S. policymakers must ensure competitive development to avoid ceding operational advantage in the region's most contested maritime domain.

Sustaining a technological advantage in the South China Sea will require targeted U.S. investment in maritime AI and autonomous systems, with an emphasis on integrating commercial innovation into defense applications. Unlike China's state-led model, the U.S. must bridge gaps between private R&D and operational deployment, especially in edge computing, multi-domain fusion, and autonomous coordination. Programs like the Replicator Initiative signal a shift toward faster acquisition cycles, but success will hinge on aligning strategic priorities with the innovation pace of the commercial sector.[xxxiii] The resiliency of such advanced systems further relies on underlying energy infrastructure. Investment into reliable power generation and advanced power grids will be critical in scaling AI-enabled naval systems.

The U.S. must further prioritize the development of advanced cyberwarfare and AI-resilient infrastructure. The PLA's reliance on sensor fusion, AI-supported command networks, and autonomous coordination introduces new vulnerabilities, particularly in system coherence, data integrity, and decision-making reliability. In the short term, U.S. forces must leverage existing cyber and electronic warfare assets to disrupt, deceive, or overload China's surveillance and C2 infrastructure, including by targeting data links, spoofing sensor inputs, and exploiting weaknesses in network integration. Over the long term, cyber operations must evolve to counter adversarial AI, harden U.S. systems against manipulation, and ensure operational advantage across contested digital and electromagnetic domains.

The AUKUS security partnership, linking Australia, the United Kingdom, and the United States, offers a clear framework for this effort. While AUKUS Pillar I centers on nuclear submarine development, Pillar II focuses on advanced capabilities such as AI-enabled ISR, uncrewed systems, and joint C2.[xxxiv] Through initiatives like the MUSIC system and Common Control System (CCS), AUKUS partners are developing interoperable platforms capable of integrating sensor feeds from U.S., Australian, and British forces into a shared battlespace picture.[xxxv] In contrast to China's unilateral C2 architecture, AUKUS efforts fuse allied assets, military and commercial, into a distributed surveillance network. Joint experiments have already demonstrated the ability to pass targeting data across national forces in seconds, creating a combined decision advantage. To make this architecture scalable, the U.S. must reform data classification policies, align export controls, and invest in open-architecture systems.

The strategic balance in the South China Sea will hinge less on who fields the most advanced platforms and more on who can generate, secure, and act on information faster and more effectively. China is building an architecture designed to compress time, obscure intent, and deny access; the U.S. must respond with systems that are distributed, resilient, and fused with allied capability. Preserving deterrence in the SCS requires more than technological advancement and presence; it demands informational dominance.

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Appendix

Table 1

AV Name	Type	Status	Use Case	Missions	Next-Gen Tech	Autonomy and Control	Payload, Sensors	Developer	Year Shown/Released
Yunzhou L30, "Watcher" [xxxvi]	Small USV	Operational	Dual-use, military/police	Coastal patrol	AI Navigation, Swarm ops, EO/IR sensors	Autonomous, remote control	Radar, EO/IR	Yunzhou Tech	2022
Yunzhou M75, "Protector" [xxxvii]	Small USV	Operational	Dual-use, oil/gas and patrol	Supply delivery and security	Obstacle avoidance	Remote and autonomous	Basic sensors	Yunzhou tech	2022
JARI-USV, [xxxviii]	Medium Combat USV	Prototype	Military	ISR, ASW, Strike	AESA radar, VLS	Fully autonomous, swarm capable	Radar, EO/IR, Missiles, Torpedos	CSSC	2019
JARI-USV-A "Orca" [xxxix]	Large Combat USV	Prototype	Military	Long range ISR, Strike	Edge AI, UAV Deck	Sat linked, autonomous	VLS, RWS, radar, sonar	CSSC	2024
HSU-001 [xl]	Large UUV	Operational (Limited)	Military	ISR, seafloor mapping	Twin Screws, sonar	Semi-Autonomous	Sonar, EO, Mast sensors	PLA Navy	2019
XLUUV [xli]	XL UUV/Sub	Prototype	Military	Strike, Special Ops, Mine Laying	Modular payloads	Autonomous	Torpedos, Sonar	CSSC	2024
Haishen 6000 [xlii]	Deep-sea AUV	Operational	Dual-use	Deep ISR Mine Countermeasures	Decoy Launch, 6000m depth	Autonomous	Sonar	CSSC	2022
Sea Wing (Haiyi) Glider[xliii]	Underwater Glider	Operational	Dual-use	Ocean sensing, Sub tracking	Hydrophones	Fully Autonomous	Sonar	CSSC	2019-2024