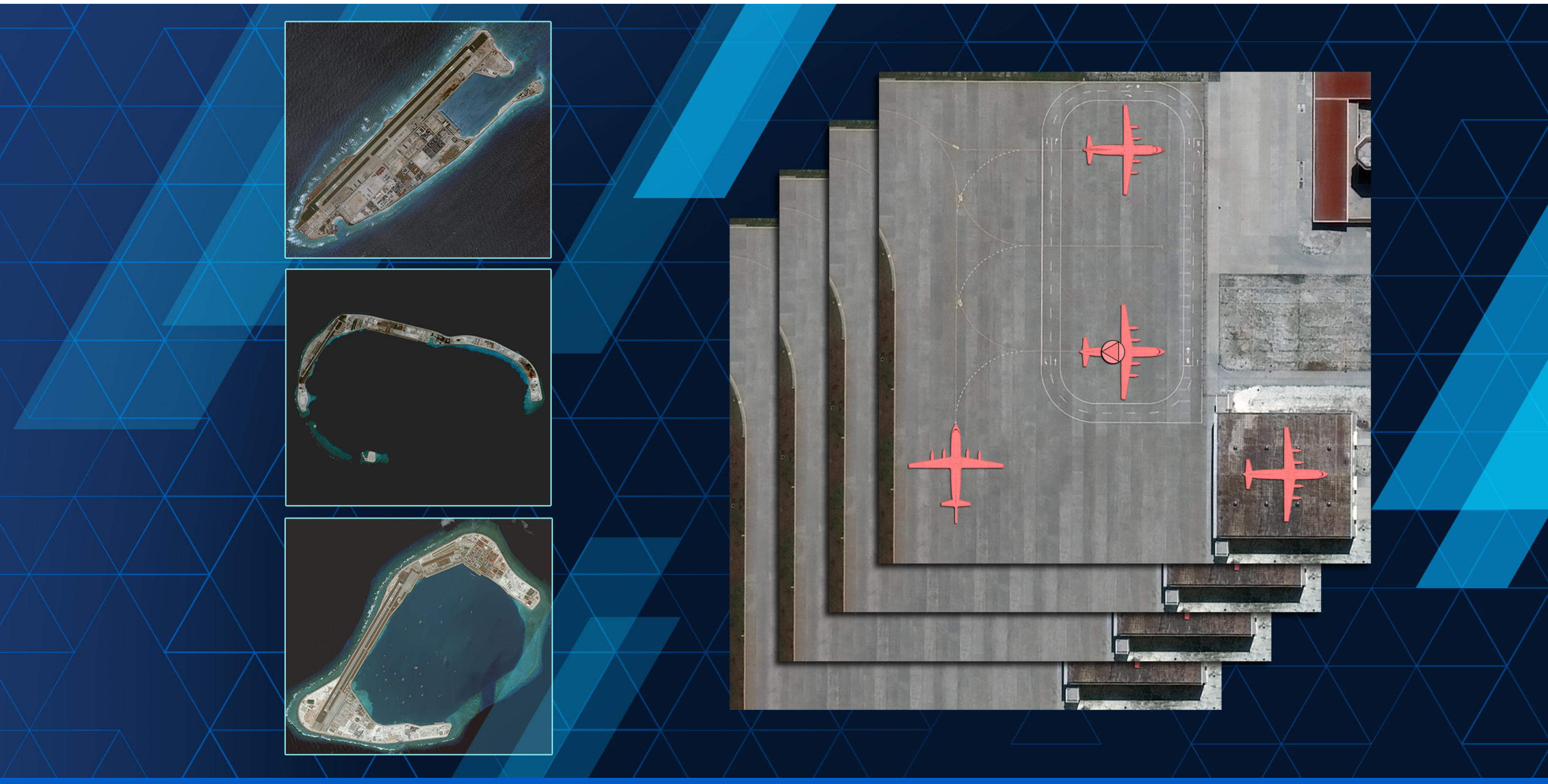
SOUTH CHINA SEA MILITARY CAPABILITY SERIES

A Survey of Technologies and Capabilities on China's Military Outposts in the South China Sea



SPECIAL MISSION AIRCRAFT AND UNMANNED SYSTEMS

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This study contains the best opinion of the author based on publicly available, open-source information at time of issue. It does not necessarily represent the assessments or opinions of JHU/APL sponsors.

 See Appendix A for notes on sources and analytic methods.

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Introduction

This military capability (MILCAP) study focuses on special mission aircraft and unmanned systems that may operate from seven Chinese island-reef outposts in the South China Sea (SCS). These SCS MILCAP studies provide a survey of military technologies and systems on Chinese-claimed island-reefs in the Spratly Islands, approximately 1,300 kilometers (700 nautical miles) south of Hong Kong (see Figure 1). These Chinese outposts have become significant People's Liberation Army (PLA) bases that will enhance future Chinese military operations in the SCS, an area where Beijing has disputed territorial claims (see Appendix B). The SCS MILCAP series highlights a PLA informationized warfare strategy to gain and maintain information control in a military conflict.

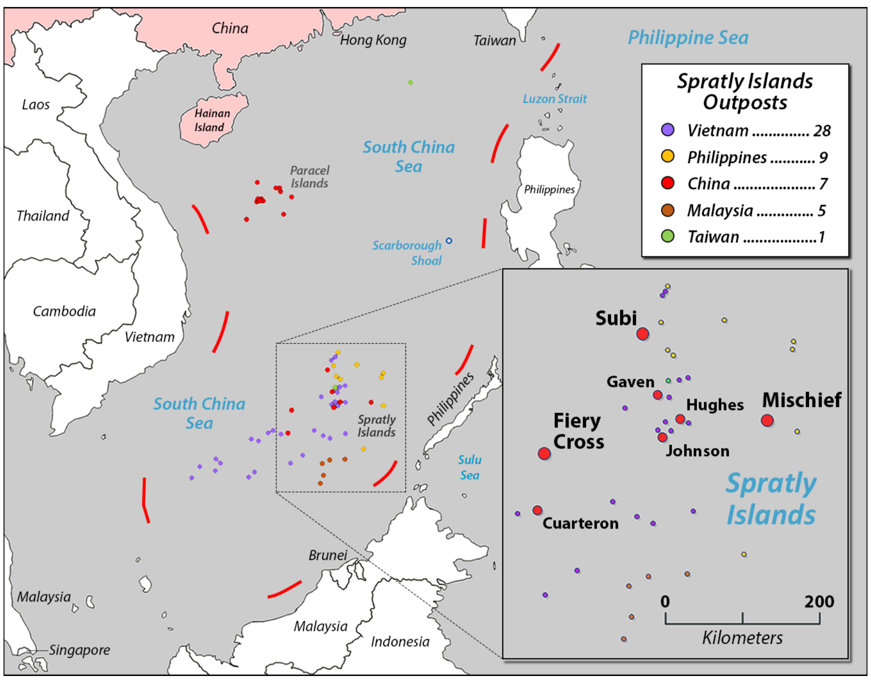


Figure 1. SCS Occupied Features

The PLA operates a variety of special mission aircraft and unmanned systems that may be deployed to China's SCS outposts. Diverse surveillance and communications platforms will be employed in conjunction with other island-reef and ship-based information power capabilities to enhance PLA battlespace awareness. Airborne platforms in particular are key information superiority force multipliers. Operating special mission aircraft and unmanned systems from the SCS outposts during or prior to a conflict gain the PLA space and time—greater on-station time in Southeast Asian waters at ranges impossible to reach from mainland Chinese bases. Overview graphics of all capabilities noted on major outposts appear in Appendix C.

SCS Island-Reef Airfield Infrastructure

The PLA developed substantial infrastructure to support aircraft operations from its SCS island-reefs. Fiery Cross and Subi Reefs each feature 3,000-meter (9,842-foot) runways. Mischief Reef features a 2,700-meter (8,858-foot) runway (see Figure 2). These long runways and large aircraft hangers on the island-reefs can support any aircraft in the PLA inventory. News reports often speculate that such long runways were constructed to support PLA bomber aircraft. Using the island-reef outposts as a refueling point to extend bomber range is a distinct possibility.

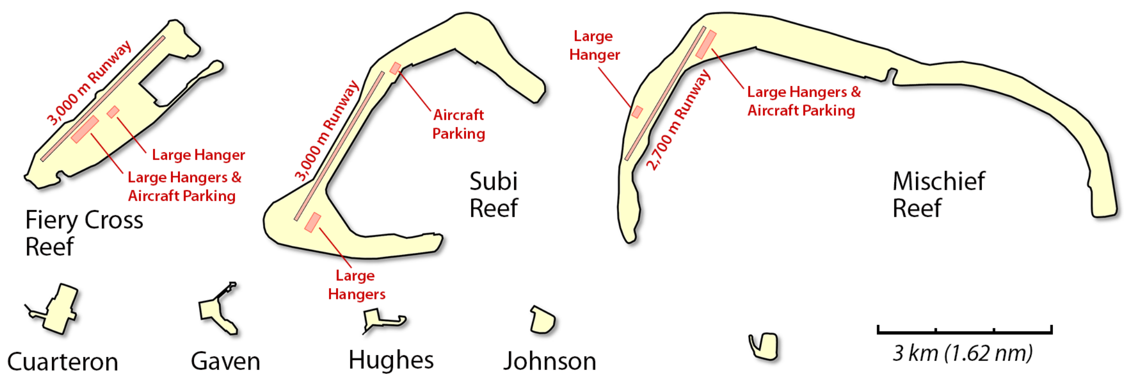
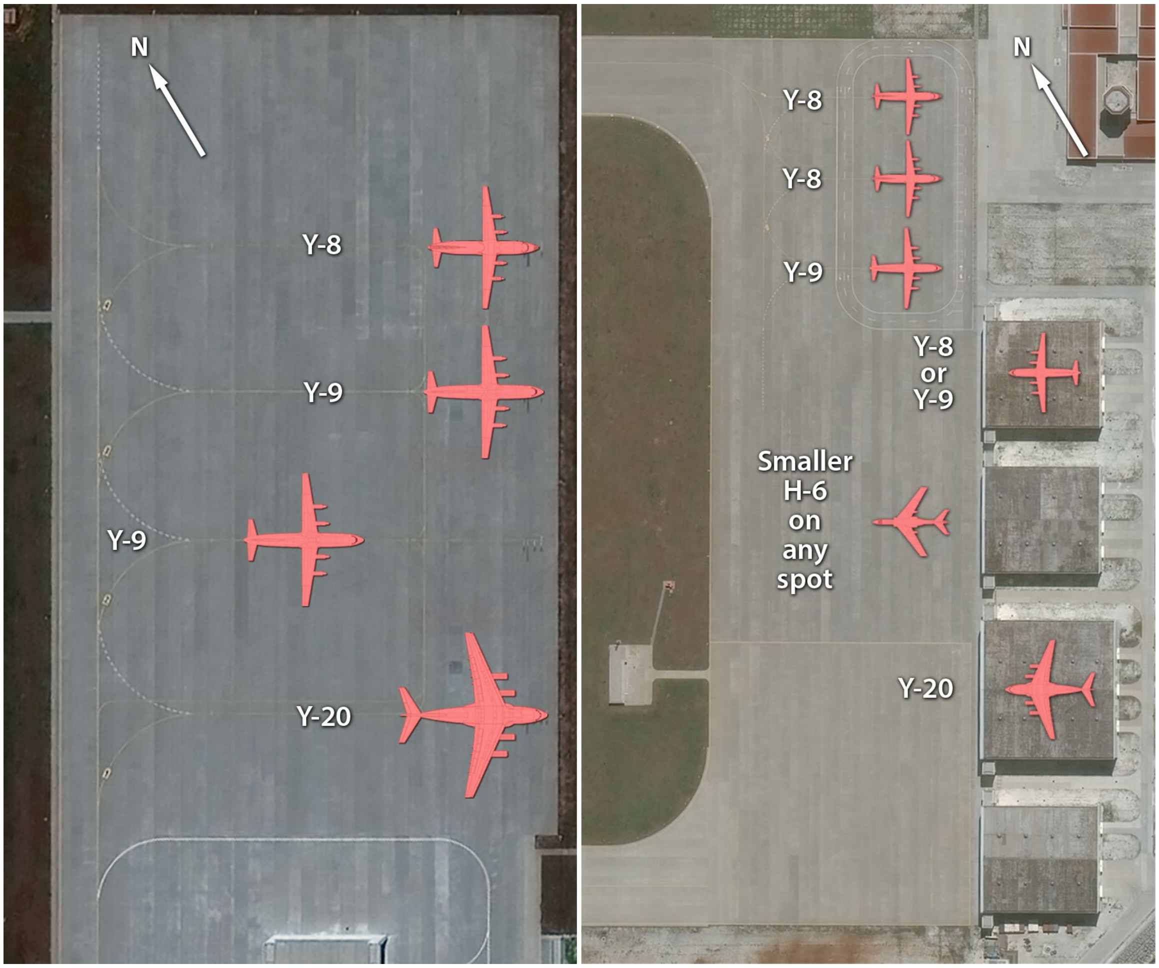


Figure 2. Airfields, Hangers, and Large Aircraft Parking

Stationing aircraft that support China's information-centric warfare strategy on the island-reefs is a more likely use of limited large aircraft support infrastructure. The PLA will probably dedicate island-reef resources to aircraft capable of command, control, and communications (C3); intelligence, surveillance, and reconnaissance (ISR); or electronic warfare, commonly called special mission aircraft. In keeping with China's informationized warfare strategy, these platforms represent the most important capabilities in an SCS conflict in which the PLA will seek to achieve battlespace information control. C3 and ISR aircraft operating from the island-reefs are more responsive and enjoy three to four hours more on-station time in the SCS over special mission aircraft launched from the Chinese mainland.

Space for large aircraft is very limited on the major Chinese island-reefs. An analysis of taxi lines, parking areas, and hangars indicates that there is ramp parking for three to four Y-8 or Y-9 sized aircraft, either transports or special mission aircraft described in subsequent sections. There are also parking lines for one very large Y-20 or IL-76-sized aircraft on Mischief and Fiery Cross Reefs. Each island-reef airfield has four or five large hangars that could accommodate a mix of special mission aircraft, transports, or bombers. PLA H-6 bombers could occupy any of the ramp or hangar spaces because the bombers are smaller than either Y-8 or Y-9 aircraft (see Figure 3).



(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 3. Large Aircraft Parking on Subi Reef (Left) and Mischief Reef (Right)

The Chinese outposts' runways can also accommodate any unmanned aerial vehicle (UAV) currently in the PLA inventory or under development. Chinese UAV systems are marketed for export with UAV command and control systems (CCS) that house UAV flight controls, intelligence processing systems, line-of-sight (LOS) communications, and satellite communications (SATCOM). [1] As of mid-2020, deployed UAVs had not been seen in commercial satellite imagery of SCS airfields. However, the PLA outposts may have C3 systems in place to support UAV operations. Objects that appear very similar to UAV CCS vans are located adjacent to each island-reef airfield operations building (see Figure 4).

[1] For example, "无人机通用指挥控制系统" [UAV Universal Command and Control System], trade brochure (中国航空工业集团公司 [Aviation Industry Corporation of China, Ltd.], 2018), 2.

Figure 4. Fiery Cross Reef Possible UAV Control Van (Left), Wing Loong II (GJ-2) UAV CCS Van (Right)

(Image (Left) © 2020 Maxar/DigitalGlobe, Inc., APL Photo (Right))

Special Mission Aircraft

Special mission aircraft are aircraft with specialized roles that include airborne early warning and control (AEW&C), sometimes called an airborne warning and control system (AWACS); signals intelligence/electronic intelligence (SIGINT/ELINT); or electronic attack (EA) (i.e., jamming). Anti-submarine warfare (ASW) and maritime patrol (MARPAT) aircraft also have C3/ISR functions but may have a more direct combat role in delivering weapons against submarines or surface ships. Dedicated search and rescue (SAR) aircraft and aerial refueling aircraft (i.e., tankers) may also be considered special mission aircraft.

The PLA Air Force (PLAAF) and the PLA Navy's air arm, the PLA Naval Air Force (PLANAF), operate a number of special mission aircraft. Most older Chinese special mission aircraft are based on the Y-8, a copy of the Russian An-12 transport. Newer special mission aircraft are based on the Chinese-designed Y-9 transport.[2] As of 2020, there are about half a dozen Y-9 special mission variants; many Y-8 variants are being

[2] Y is for 运 (Yùn), which means "transport."

phased out. The Shaanxi Aircraft Corporation (SAC) reportedly has been mass producing Y-9 special mission aircraft for the PLA over the past several years.[3]

The Y-9 airframe offers significant improvements over its predecessor, including a 60 percent range increase. The Y-8 has a nominal range of 3,100 kilometers (~1,700 nautical miles), while the Y-9 has a reported range of over 5,000 kilometers (~2,700 nautical miles).[4] At cruising speeds, ranges translate to a mission endurance of just under six hours for legacy Y-8 airframes and over ten hours for Y-9s. In August 2020, Chinese state television revealed an experimental Y-9/KJ-500 with a refueling probe.[5] In-flight refueling could significantly extend a Y-9 special mission aircraft's range and on-station time. There is speculation the Y-20 large transport aircraft may be adapted for specialized roles such as aerial refueling (see Figure 5).[6]

(JHU/APL Photo)

Figure 5. Y-20 Heavy Lift Transport Aircraft

Official and non-official sources refer to Chinese special mission aircraft in several different ways. The PLA's principle AEW&C aircraft, for example, may be called by its PLA system name, the 空警-500 or KJ-500. Chinese aviation enthusiasts and Internet sources may also refer to the KJ-500 by its airframe designation, the Y-9W, or by its project designator, the 高新-10 or GX-10. Project designations based on the prefix "高新" (gāoxīn, GX), meaning "high-tech," appear to be collectively assigned by

[3] Liu Xuanzun, "China Mass-Produces Special Mission Aircraft," *Global Times,* December 8, 2019, https://www.globaltimes.cn/content/1172715.shtml.

[4] "运-9 到底有多厉害？" [How Powerful is the Y-9?], *CCTV.com*, November 24, 2018, http://news.cctv.com/2018/11/24/ARTIPC0zeumXkIhGFoWUTsZS181124.shtml.

[5] Liu Xuanzun, "China's New AWACS Ready for South China Sea Missions," Global Times, September 7, 2020, https://www.globaltimes.cn/content/1200151.shtml.

[6] Andrew Tate, "Y-20 Tanker and AEW&C Variants in the Pipeline, Senior PLAAF Officer Confirms," *Jane's Defense Weekly*, February 26, 2020, https://customer.janes.com/Janes/Display/FG_2716114-JDW.

Chinese aviation enthusiasts as aircraft appear in photographs for the first time. While there are some inconsistencies in GX designations for special mission aircraft, they are nevertheless useful references when searching for images or reports of new aircraft not yet publically acknowledged by the Chinese military. Active PLA Y-8 and Y-9 special mission aircraft and their associated designators appear in Table 1.

Table 1. PLA Air Force and PLA Naval Air Force Special Mission Aircraft[7]

Aircraft Designator	GaoXin Designator	PLA System Designator	Mission	PLA Service *Notes*
Y-8G	GX-3		Electronic Attack	**PLAAF** *Being replaced by Y-9G*
Y-9G	GX-11		Electronic Attack	**PLAAF**
Y-9JB	GX-8		SIGINT/ELINT	**PLANAF**/**PLAAF**
Y-9Q	GX-6	KQ-200	ASW/MARPAT	**PLANAF**
Y-8W	GX-5	KJ-200	AEW&C	**PLANAF**/**PLAAF** *Being replaced by Y-9W/KJ-500*
Y-9W	GX-10	KJ-500	AEW&C	**PLANAF**/**PLAAF**
Y-8XZ	GX-7		Psychological Warfare	**PLAAF** *Being replaced by Y-9XZ*
Y-9XZ	GX-9		Psychological Warfare	**PLAAF**

The PLANAF operates land-based, fixed-wing aircraft and helicopters, as well as ship-based helicopters. More recently, with the advent of China's aircraft carrier program, the PLANAF also began operating carrier-based, fixed-wing aircraft. While some PLA Air Force aircraft may operate from the island-reef bases, naval aircraft are more likely candidates for deployments to the SCS. The PLANAF significantly increased its inventory of land-based Y-9 special mission aircraft between 2015 and 2020.

Following the 2016 nation-wide reorganization of the PLA into regionally oriented theaters, the Southern Theater Command became responsible for military operations

[7] Some Chinese sources swap the GX-9 and GX-10 designators, assigning GX-9 to the Y-9W/KJ-500. See, for example, 蓝星观察 [Blue Star Observer], "运 8 运 9 改造的高新家族" [High-Tech Family Transformed by Y-8 and Y-9], *知乎 Zhihu* (blog), July 11, 2018, https://zhuanlan.zhihu.com/p/39510289. Other sources hold the Y-9W/KJ-500 as the GX-10. See, for example, "SAC Y-9 (Special Mission Versions)," *Jane's All the World's Aircraft*, July 2, 2020, https://customer.janes.com/Janes/Display/jawaa259-jawa.

in the SCS. In 2016, the Southern Theater navy component created a new special mission aircraft division.[8] PLANAF special mission aircraft, including the KJ-500 AEW&C aircraft, the KQ-200 ASW/MARPAT aircraft, and the Y-9JB SIGINT/ELINT aircraft, will likely deploy from this new PLANAF Southern Theater special mission aircraft division to the SCS outposts. Deployments from other PLA theaters (i.e., the Northern Theater or Eastern Theater) may occur during exercises or crises.

The three new types of special mission aircraft—KJ-500, KQ-200 and Y-9JB—and an older PLANAF KJ-200 AEW&C aircraft appeared in a fly-by during China's 2019 national day parade. The echelon of aircraft were described as a "new type of naval information warfare force."[9] In April 2020, KJ-500 AEW&C and KQ-200 ASW/MARPAT aircraft, both likely belonging to the PLANAF, were spotted by commercial satellite imagery at the airfield on Fiery Cross Reef in their first SCS deployment.[10]

Airborne Early Warning and Control

The PLANAF introduced its first maritime airborne early warning (AEW) aircraft, the Y-8J, in the late 1990s (see Figure 6).[11] By the early 2000s, the PLAAF operated China's first generation AEW&C aircraft, the large KJ-2000, based on a Russian IL-76 airframe.[12] In the 2010s, both the PLAAF and PLANAF operated the Y-8W AEW&C aircraft, also known as the KJ-200 or GX-5. The KJ-200 features a large SAR, often called a "plank" or "balance beam" radar (see Figure 6).[13] The Y-8J and KJ-200 are being phased out of the PLANAF and PLAAF inventories, replaced by the third-

[8] Brendan Mulvaney and Ken Allen, *PLA Aerospace Power: A Primer on Trends in China's Military Air, Space and Missile Forces*, 2nd ed. (Montgomery, AL: China Aerospace Studies Institute, Air University, 2020), 34.

[9] Huang Shubo and Zhou Zhengxin, "海上巡逻机梯队：海军新型信息作战力量首次集体亮相" [Maritime Patrol Aircraft Echelon: First Collective Appearance of the Navy's New Information Combat Force], *解放军报* [*PLA Daily*], October 1, 2019, http://www.81.cn/2019jg70znyb/2019-10/01/content_9641619.htm.

[10] "Fiery Cross Reef: Permanent Base for ISR Aircraft in the South China Sea," ImageSat International, June 14, 2020, https://storymaps.arcgis.com/stories/476d0c84a9f84046b9866db8f9405f72.

[11] Joint Staff, 中国機の東シナ海及び日本海における飛行について [Chinese aircraft flying in the East China Sea and Sea of Japan], press release (Tokyo: Japanese Ministry of Defense, August 18, 2016), http://www.mod.go.jp/js/Press/press2016/press_pdf/p20160818_01.pdf. The Japanese Self-Defense Force (JSDF) periodically intercepts and photographs PLAAF and PLANAF special mission aircraft operating in the Sea of Japan and the East China Sea. These officially-released, close-up photographs of PLAAF and PLANAF aircraft make convenient references and are cited throughout this study.

[12] "KJ-2000 (Mainring) Airborne Early Warning and Control (AEW&C) Aircraft," *Air Force Technology*, accessed August 15, 2020, https://www.airforce-technology.com/projects/kj-2000-aewc-aircraft/.

[13] Joint Staff, 中国機の東シナ海における飛行について [Chinese aircraft flying in the East China Sea], press release (Tokyo: Japanese Ministry of Defense, November 27, 2015), http://www.mod.go.jp/js/Press/press2015/press_pdf/p20151127_02.pdf.

generation KJ-500 AEW&C aircraft. At the 2019 International Defense Exhibition in Abu Dhabi, Chinese arms conglomerate Poly Technologies offered surplus KJ-200 aircraft for sale to international customers.

(JSDF Photos)

Figure 6. Y-8J Maritime AEW Aircraft (Left) and Y-8W/KJ-200 AEW&C Aircraft (Right)

KJ-500. The KJ-500, also known as the Y-9W or GX-10, is the primary AEW&C aircraft for the PLAAF and PLANAF (see Figure 7). The PLAAF received its first KJ-500 in 2015.[14] "KJ" stands for "空警" (kōng jǐng), meaning "air alert" or "air warning." According to Chinese state media, the designation for PLANAF KJ-500 aircraft is KJ-500H.[15] As of 2020, the PLANAF maintained as many as four KJ-500Hs in the Southern Theater at PLA Navy airfields in Lingshui and Yongzhou Lingling.[16]

(JHU/APL Photo)

Figure 7. KJ-500 AEW&C Aircraft

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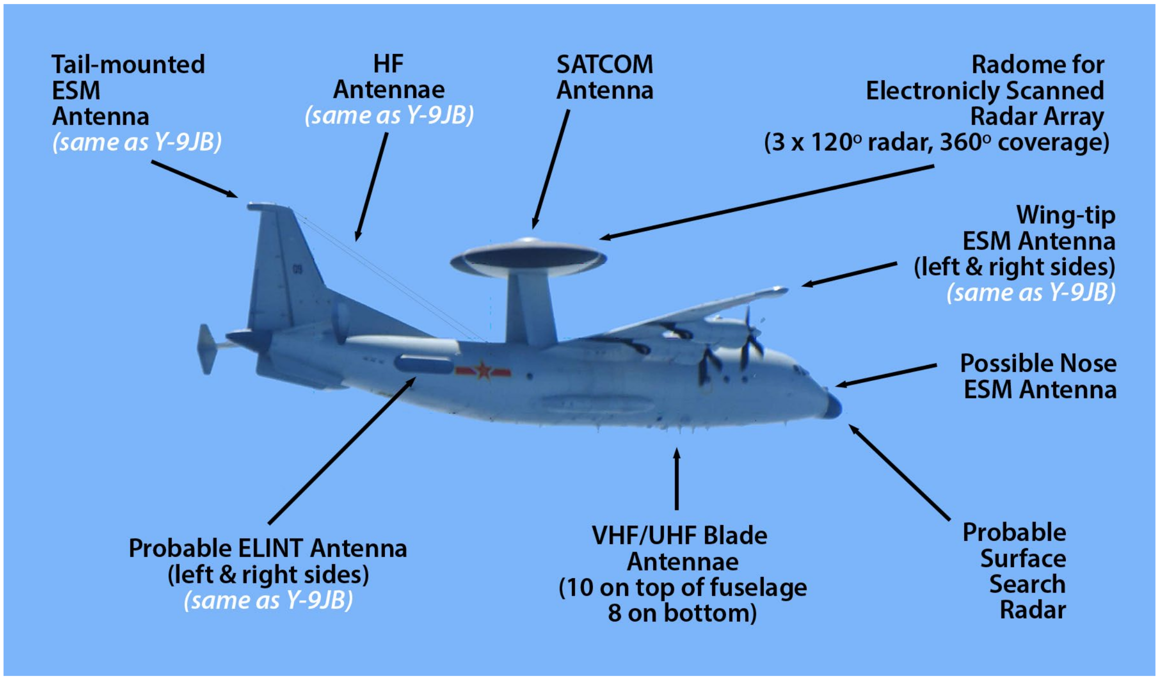
[14] Richard D. Fisher, "China's KJ-500 AEW&C Platform 'Enters Service,'" *Jane's Defence Weekly*, March 24, 2015, https://customer.janes.com/Janes/Display/jdw58115-jdw-2015.

[15] "H" may be for "海" [hǎi], meaning "sea" or "naval." Huang and Zhou, "海上巡逻机梯队" [Maritime Patrol Aircraft Echelon].

[16] See 3 x KJ-500H, Google Earth Pro 7.3.3.7721, (January 31, 2019) Lingshui Airfield, China, 18°29'53"N 109°59'00"E. Maxar Technologies 2020. See 1 x KJ-500H, Google Earth Pro 7.3.3.7721, (September 9, 2019) Yongzhou Lingling Airfield, China 26°19'47"N 111°36'46"E. Maxar Technologies 2020. See also, Sean O'Connor, "China's Yongzhou Lingling Airport Likely to Have Expanded Military Role," *Jane's Defence Weekly*, June 6, 2018, https://customer.janes.com/Janes/Display/FG_950947-JDW.

Figure 8 depicts the external features of the KJ-500. The aircraft has a dorsal-mounted radome that houses three phased array radars, each covering 120 degrees, yielding 360-degree coverage. This array is most likely optimized for air search functions, although a surface search capability cannot be ruled out. A separate surface search radar is probably housed in the KJ-500's nose cone. Probable ELINT antennae to detect radar signals are located on the left and right sides of the aft fuselage. This housing is identical to that found on the Y-9JB SIGINT/ELINT aircraft. Chinese sources referred to this lateral array as a "radar antenna." [17] While it is possible that this housing could contain an active SAR, Chinese sources sometimes refer to ELINT antennas as "passive radars."[18]



(JSDF Photo/Annotations by Author)

Figure 8. Annotated Image of KJ-500 AEW&C Aircraft

In addition to the ELINT array, the KJ-500 appears to have electronic support measure (ESM) antennae surrounding the aircraft that may provide threat radar warning from all directions. The KJ-500 features probable tail and wing-tip mounted

[17] "运−9 到底有多厉害?" [How Powerful is the Y-9?], *CCTV.com*.

[18] Passive radar (被动雷达) refers to a system that uses target reflections from sources such as commercial broadcasts. While an ELINT system seeks target transmission sources, a passive radar receiver is essentially and ELINT receiver tuned to the background signals. Occasionally, Chinese sources have used "passive radar" to refer to what should be termed ELINT systems.

ESM antennae, again identical to the Y-9JB SIGINT/ELINT aircraft. There is also a protrusion above the nose cone assessed to be a forward-looking ESM antenna.[19]

To fulfill its airborne control mission, the KJ-500 bristles with communications antennae. A SATCOM antenna dome is mounted atop the radar. Two high-frequency (HF) antennae are strung between the tail and the fuselage. As many as eighteen very-high frequency (VHF) or ultra-high frequency (UHF) blade antennae are mounted above and below the fuselage. These antennae likely support multiple channels of voice communications as well as datalinks. For additional information on PLA data links, see the SCS MILCAP study, "Inter-Island Communications."

KJ-600. A probable prototype aircraft carrier-based AEW&C aircraft, dubbed KJ-600, was spotted in commercial satellite imagery at an airfield in Xi'an, China in August 2020.[20] Chinese aviation enthusiasts speculated for years about a smaller twin-engine version of the KJ-500 that could operate from Chinese aircraft carriers. Artist renderings of the KJ-600 look very similar to the US Navy E-2D Hawkeye AEW&C aircraft. Speculation about the KJ-600 has been fueled by the appearance of a mock-up of an AEW&C aircraft that appeared atop a building in Wuhan, China in 2017 (see Figure 9).[21] The roof of the 701st Research Institute building is fashioned into an aircraft carrier flight deck, presumably for training and experimentation.[22] A carrier-based AEW&C aircraft would have to operate from a future Chinese aircraft carrier with catapults that could launch the relatively heavy aircraft. China's current generation aircraft carriers rely on ski jump ramps to assist launching jet aircraft. Until aircraft carriers with catapults are available, the SCS island-reef airfields are excellent forward-deployed airfields from which either PLANAF KJ-500 or a future KJ-600 may operate in support of PLA Navy aircraft carrier operations in the southern reaches of the SCS.

[19] Alessandra Giovanzanti and George Papangelopoulos, "Chinese Special Mission Aircraft: An Overview of Airborne Early Warning (AEW) Capabilities," (intelligence briefing, Jane's, July 3, 2020), 14, https://customer.janes.com/Janes/Display/FG_3224977-JIBR.

[20] H.I. Sutton, "First Image of China's New Carrier-Based AEW Plane," *Forbes*, August 29, 2020, https://www.forbes.com/sites/hisutton/2020/08/29/first-image-of-chinas-new-carrier-based-aew-plane/

[21] See KJ-600 mock up, Google Earth Pro 7.3.3.7721, (October 16, 2019) Wuhan, China, 30°25'21"N 114°15'44"E. Maxar Technologies 2020. See also, 国平军史 [Guópíng jūn shǐ] "空警-600 舰预警机即将横空出世" [KJ-600 AWACS is About to Come into Being], *Toutiao* (blog), June 23, 2019, https://toutiao.dingdingwork.com/48/car/909ca466962d11e98e4600163e13b461.

[22] "Chinese Carrier on Land Arouses Another Round of Hype," *China Military Online*, January 22, 2015, http://eng.mod.gov.cn/Opinion/2015-01/22/content_4566458.htm.

(Image Google Earth/© 2020 CNES/Airbus)

Figure 9. KJ-600 Mock-Up on Aircraft Carrier Mock-Up, Wuhan, China

Anti-Submarine Warfare / Maritime Patrol

The Y-8X MARPAT aircraft began operations with the PLANAF in the mid-1980s. The Y-8X was among the first PLANAF special mission aircraft and still conducted overwater operations in the early 2010s (see Figure 10).[23] The PLANAF's small inventory of Y-8X aircraft has likely been replaced by larger numbers of the new KQ-200/Y-9Q.

(JSDF Photo)

Figure 10. Y-8X Maritime Patrol Aircraft

[23] Joint Staff, 中国機の東シナ海における飛行について [Chinese aircraft flying in the East China Sea], press release (Tokyo: Japanese Ministry of Defense, March 2, 2011), http://www.mod.go.jp/js/Press/press2011/press_pdf/p20110302.pdf.

KQ-200. The KQ-200, also known as the Y-9Q or GX-6, is the PLANAF's ASW/MARPAT aircraft. There are no indications the KQ-200 is in service with the PLAAF. The PLANAF received its first KQ-200 in 2015. "KQ" stands for "空潜" (kōng qián), denoting "air-submarine," highlighting the KQ-200's anti-submarine role. KQ-200 deployments to the Southern Theater, specifically the PLANAF's Lingshui airfield, were noted in commercial imagery in 2017.[24] By mid-2020, the Qionghai-Bo'ao civil-military airfield on Hainan Island appeared to be a primary deployment airfield for the KQ-200. Seven KQ-200 ASW/MARPAT aircraft were noted at the Bo'ao airfield in July 2020, the most detected in commercial imagery in the PLA's Southern Theater (see Figure 11).[25] These ASW/MARPAT aircraft and the single KQ-200 deployed to Fiery Cross Reef in mid-2020 may include KQ-200s deployed from other theaters in support of a mid-2020 Southern Theater military exercise.[26]

(Image Google Earth/© 2020 CNES/Airbus)

Figure 11. Seven KQ-200 at Qionghai-Bo'ao Airfield, Hainan Island, China

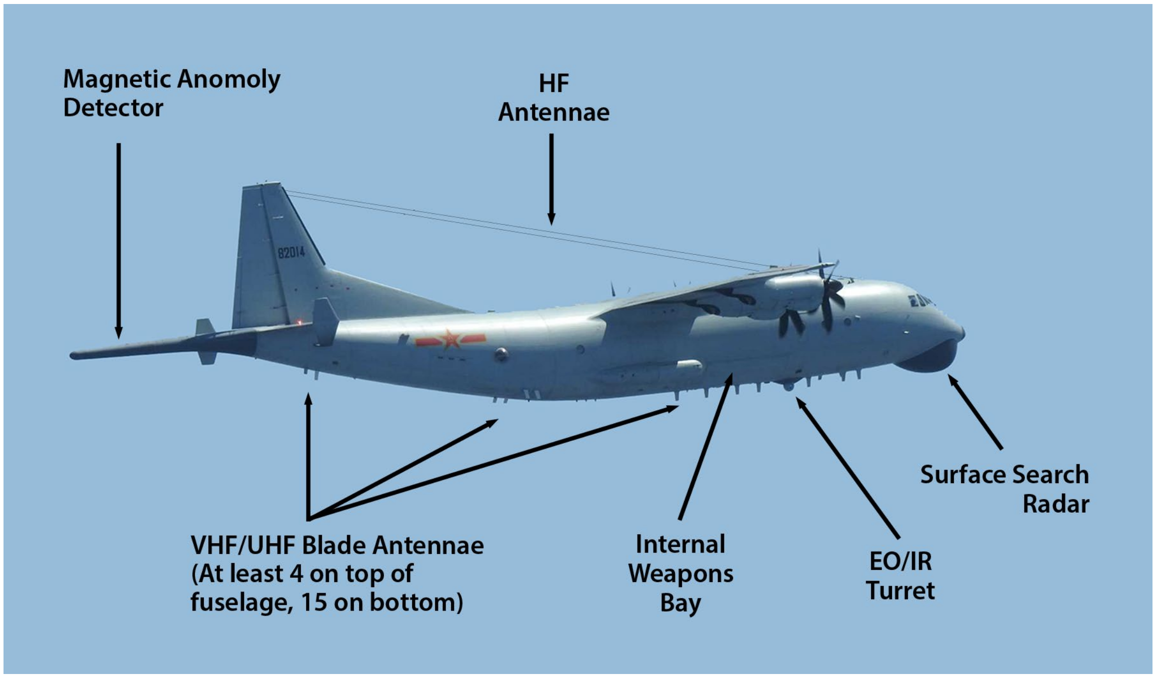
Figure 12 depicts the external features of the KQ-200. The primary recognition feature of the KQ-200 is its elongated tail formed by a magnetic anomaly detector (MAD) boom. MAD booms detect magnetic field variations when the aircraft flies over

[24] Mike Yeo, "China Deploys New Anti-Submarine Aircraft to Fringes of South China Sea," *Defense News*, June 22, 2017, https://www.defensenews.com/space/2017/06/22/china-deploys-new-anti-submarine-aircraft-to-fringes-of-south-china-sea/.

[25] See 7 x KQ-200H, Google Earth Pro 7.3.3.7721, (July 6, 2020) Qionghai-Bo'ao Airfield, China, 19°08'36"N 110°27'16"E. CNES/Airbus 2020.

[26] "People's Republic of China Military Exercises in the South China Sea," U.S. Department of Defense (press release), July 2, 2020, https://www.defense.gov/Newsroom/Releases/Release/Article/2246604/peoples-republic-of-china-military-exercises-in-the-south-china-sea/.

large metallic objects, such as submerged submarines. A probable surface search radar is located under the chin of the aircraft. A camera turret for electro-optic/infrared (EO/IR) surveillance is mounted under the fuselage.



(JSDF Photo/Annotations by Author)

Figure 12. Annotated Image of KQ-200 ASW/MARPAT Aircraft[27]

The KQ-200 HF antennae strung from the tail are longer than HF antennae on the KJ-500 and Y-9JB and are therefore capable of transmitting and receiving at lower frequencies. At least nineteen VHF/UHF blade antennae are located above and below the fuselage for voice communications or data links. Some of these blade antennae are likely used to communicate with sonobuoys dropped from the aircraft to acoustically track submarines. Blade antennae could also be used for ELINT or signal direction finding. However, it appears that ELINT functionality has largely been incorporated into PLANAF's Y-9JB discussed in the next section. Doors on the left and right side of the KQ-200 open to reveal an internal weapons bay for torpedoes and depth charges. The KQ-200 is purported to carry anti-ship cruise missiles, either internally or on wing-mounted hard points, but this has not been confirmed.[28]

[27] Joint Staff, 中国機の東シナ海における飛行について [Chinese aircraft flying in the East China Sea], press release (Tokyo: Japanese Ministry of Defense, March 20, 2019), https://www.mod.go.jp/js/Press/press2019/press_pdf/p20190320_01.pdf.

[28] Xavier Vavasseur, "New Details on China's KQ-200 Maritime Patrol Aircraft," *Naval News*, April 29, 2019, https://www.navalnews.com/naval-news/2019/04/new-details-on-chinas-kq-200-maritime-patrol-aircraft/.

Figure 13 depicts calculated radar coverage for one KJ-500 AEW&C aircraft flying at 25,000 feet and two KQ-200 ASW/MARPAT aircraft flying at 10,000 feet. Depending on signal strength, SIGINT/ELINT LOS collection ranges for the KJ-500 or Y-9JB (described in the next section) are identical to radar coverage ranges.

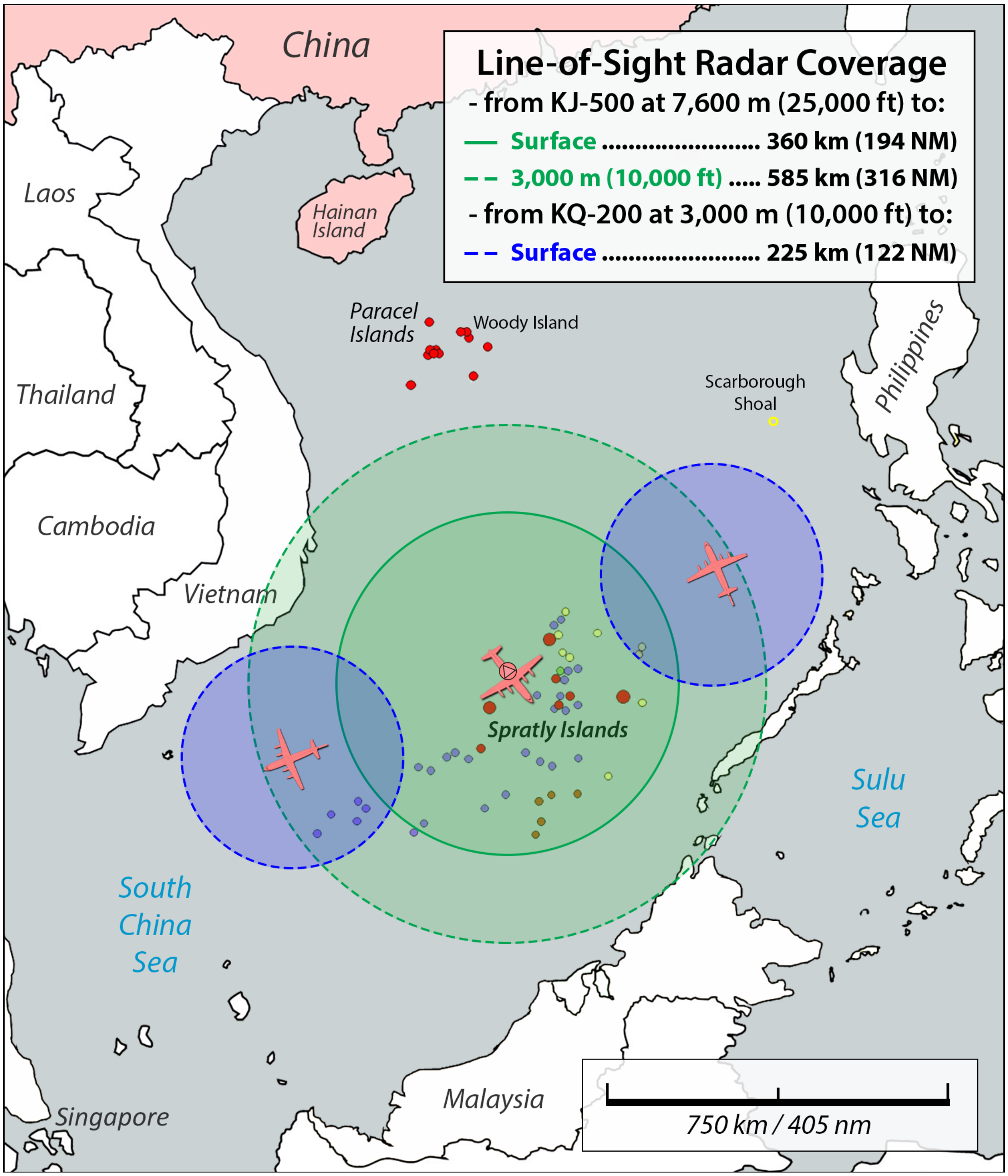


Figure 13. Line-of-Sight Radar Coverage from KJ-500 and KQ-200 Aircraft

Electronic Warfare/Electronic Intelligence

Passive electronic warfare (EW) capabilities are found in SIGINT and ELINT special mission aircraft, sometimes called electronic support measures (ESM) aircraft. These reconnaissance aircraft detect, intercept, identify, and locate electromagnetic signals of interest. The Y-8JB ELINT collection aircraft was reportedly the second project in the "high-tech" (Gaoxin) series, dubbed the GX-2. This PLANAF special mission aircraft was still conducting overwater operations in the early 2010s (see Figure 14).[29] The Y-8JB has been replaced by the Y-9JB in both the PLAAF and PLANAF.

(JSDF Photo)

Figure 14. Y-8JB ELINT Aircraft

Y-9JB. Little official information is available about the Y-9JB SIGINT/ELINT aircraft compared to that acknowledged by the PLA about the KJ-500 and KQ-200. Chinese state media only refer to the Y-9JB as a "technical reconnaissance aircraft" (技术侦察机).[30] The Y-9JB has been dubbed the GX-8, but the aircraft's PLA system designator has not been revealed. In late 2019, the Y-9JB was sighted with a new paint scheme alleviating any questions about this aircraft's affiliation. "China Navy" (中国海军) and the PLA Navy flag appears prominently on the forward fuselage (see Figure 15).

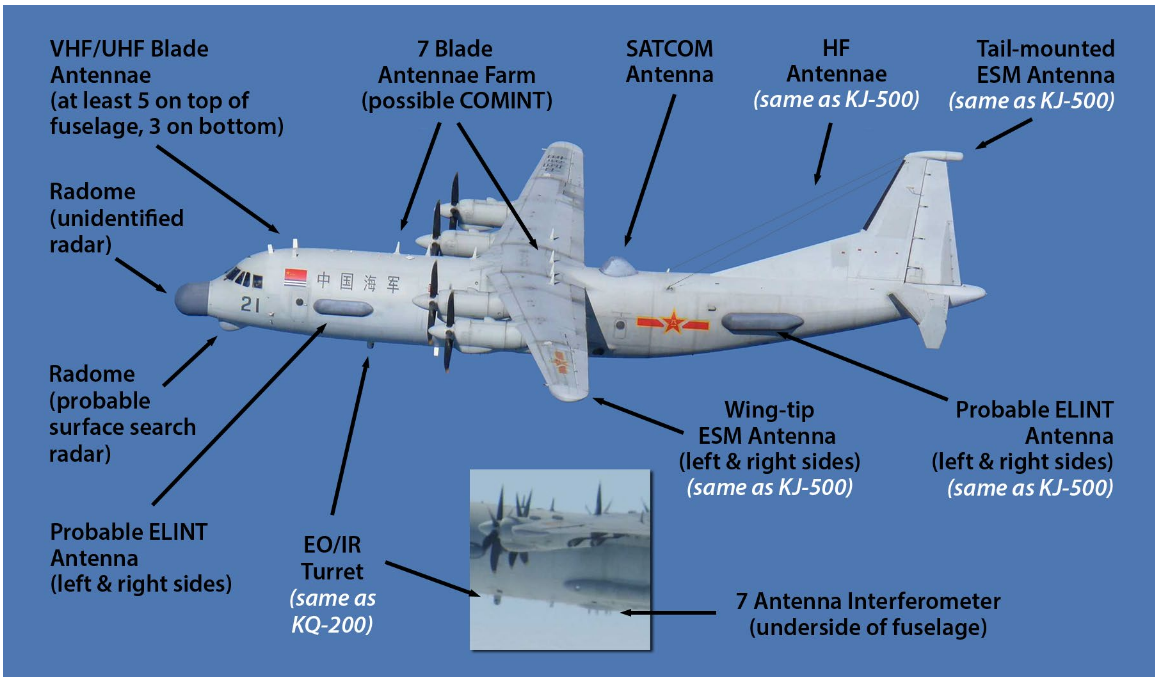
Figure 15 depicts the external characteristics of the Y-9JB. The aircraft has a number of features that appear identical to the KJ-500, including wing-tip and tail-mounted ESM antennae, probable ELINT arrays on the rear fuselage, and HF antennae strung from the tail.[31] An EO/IR turret is also positioned under the fuselage in the same

[29] Joint Staff, 中国機の東シナ海における飛行について [Chinese aircraft flying in the East China Sea], press release, March 2, 2011.

[30] Huang and Zhou, "海上巡逻机梯队：海军新型信息作战力量首次集体亮相" [Maritime Patrol Aircraft Echelon: First Collective Appearance of the Navy's New Information Combat Force].

[31] Joint Staff, 中国機の東シナ海及び日本海における飛行について[Chinese Aircraft Flying in the East China Sea and Sea of Japan], press release (Tokyo: Japanese Ministry of Defense, October 10, 2019), https://www.mod.go.jp/js/Press/press2019/press_pdf/p20191029_01.pdf.

location as the KQ-200. The Y-9JB dorsal-mounted SATCOM radome and the bulbous nose cone are the most readily identifiable features of this aircraft in commercial satellite images. There is speculation that the nose cone of the Y-9JB houses a SAR.[32] A chin-mounted radome that appears identical to a radome on the KJ-200 may house an active surface-search radar.[33] The Y-9JB may use these active radar systems to cross-check passive SIGINT/ELINT collection with active radar contacts in some circumstances.



(JSDF Photo/Annotations by Author)

Figure 15. Annotated Image of Y-9JB SIGINT/ELINT Aircraft

The Y-9JB features what is probably another pair of ELINT antennae on either side of the forward fuselage. There is a possibility these fairings house a SAR that works in conjunction with the nose-mounted SAR. A field of seven blade antennae arrayed over the wings and toward the front of the aircraft may have a communications intelligence (COMINT) function. What appears to be a seven-blade interferometer is

[32] Alessandra Giovanzanti and George Papangelopoulos, “Chinese Special Mission Aircraft: An Overview of Electronic Warfare Capabilities,” (intelligence briefing, Jane’s, June 27, 2019), 15, https://customer.janes.com/Janes/Display/FG_2109989-JIBR.

[33] Giovanzanti and Papangelopoulos, “Chinese Special Mission Aircraft: An Overview of Airborne Early Warning (AEW) Capabilities,” 12.

also mounted on the underside of the fuselage.[34] This circular array of antennae uses differences in angle of arrival to determine the bearing to an electromagnetic signal. The Y-9JB has half the number of VHF/UHF blade antennae as the KJ-500 or KQ-200. This indicates that the Y-9JB's mission may be limited to surveillance and data collection without an explicit command and control function like the other two special mission aircraft.

Electronic Warfare/Electronic Attack

SIGINT/ELINT aircraft attempt to control the electromagnetic spectrum through passive collection and targeting. In contrast, electronic attack (EA) aircraft represent corresponding active measures to deny use of the electromagnetic spectrum to an adversary. EA necessarily involves detection and localization of signals either from an aircraft like the Y-9JB or from an EA aircraft itself. EA takes the form of noise/barrage jamming that overwhelms targeted receivers and deceptive jamming where radar or communications receivers are deceived or spoofed, confusing the adversary receiver or creating false targets. As of mid-2020, the PLA Navy does not appear to have any purpose-built EA special mission aircraft. EA special mission aircraft are flown only by the PLAAF. PLAAF EA aircraft may still deploy to the island-reef airfields to increase responsiveness and on-station time in the SCS, especially in the context of a military conflict.

PLAAF EA aircraft include the Y-8G and its recently identified follow-on, the Y-9G.[35] Chinese aviation enthusiasts sometimes refer to the Y-8G as "mumps" because of the antenna housings that protrude from the left and right sides of the forward fuselage (see Figure 16).[36] Given their size, the Y-8G and Y-9G likely generate substantial electronic interference across a broad frequency range.

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[34] Giovanzanti and Papangelopoulos, "Chinese Special Mission Aircraft: An Overview of Electronic Warfare Capabilities," 12.

[35] "中国电子对抗重要作战力量首揭面纱" [China's Important Electronic Confrontation Combat Force Revealed], 央视网 [CCTV], October 5, 2019, http://news.cctv.com/2019/10/05/ARTInw0VjIastAm7wO5nAUOH191005.shtml. See also, "阅兵训练场的故事" [Story of the Military Parade Training Ground], 央视新闻客户端 [CCTV News Client] (video), October 5, 2019, http://m.news.cctv.com/2019/10/05/ARTIRpLgOpLaW5WkhbZROqyV191005.shtml

[36] Joint Staff, 中国機の東シナ海及び太平洋における飛行について [Chinese aircraft flying in the East China Sea and Pacific Ocean], press release (Tokyo: Japanese Ministry of Defense, December 9, 2017), http://www.mod.go.jp/js/Press/press2017/press_pdf/p20171209_01.pdf.

PLAAF EW/EA aircraft like the Y-8G escorted PLAAF H-6 bombers conducting simulated operations over the East China Sea and Philippine Sea.[37] In the absence of dedicated PLANAF EW/EA aircraft, PLA Navy aircraft have been equipped with electronic countermeasure (ECM) pods that are carried on PLANAF H-6G bombers or JH-7 fighter-bombers (see Figure 17).[38] The large jamming pods noted in Internet images on the H-6G apparently provide more than just a self-protection jamming capability.[39] The PLANAF H-6G jamming pods reportedly provide EA capabilities similar to those of other, large EW special mission aircraft. H-6G with ECM pods may deploy to the SCS outposts to provide the PLANAF with a stand-off EA capability.

(JSDF Photo)

Figure 16. Y-8G EW/EA Aircraft

(JSDF Photo)

Figure 17. PLANAF H-6G Bomber (without Jamming Pods) [40]

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[37] Joint Staff, 中国機の東シナ海及び太平洋における飛行について [Chinese aircraft flying in the East China Sea and Pacific Ocean], press release (Tokyo: Japanese Ministry of Defense, April 15, 2019), https://www.mod.go.jp/js/Press/press2019/press_pdf/p20190415_01.pdf.

[38] Deng Xiaoci, "PLA Navy Deploys 'New Type of Electronic Warfare Aircraft," *Global Times*, January 21, 2018, https://www.globaltimes.cn/content/1085865.shtml.

[39] Zhang Qiang, "小吊舱让轰-6G 变身电子攻防多面手" [Small Pod Turs H-6G into an Attack and Defense All-Rounder], *科技日报社 [Science and Technology Daily]*, January 31, 2018, http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2018-01/31/content_387627.htm

[40] Joint Staff, 中国機の東シナ海及び太平洋における飛行について [Chinese aircraft flying in the East China Sea and Pacific Ocean], press release (Tokyo: Japanese Ministry of Defense, April 1, 2019), https://www.mod.go.jp/js/Press/press2019/press_pdf/p20190401_01.pdf.

Unmanned Systems

The Chinese defense industry is offering a variety of unmanned systems for ISR and strike missions both for domestic use and international exports. Currently, the PLA's actual integration of unmanned systems appears somewhat limited. Medium-altitude, long-endurance (MALE) UAVs, similar in size and capabilities to US Predator drones, have been in use by the PLA since at least 2010. High-altitude, long-endurance (HALE) UAVs began operating with the PLA more recently.

The PLA Navy is actively experimenting with unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUVs), but neither are known to be operational with PLA forces as of mid-2020. However, Chinese research and investment in unmanned technology portends a marked increase in the use of these systems in the coming years.

Unmanned Aerial Vehicles

The PLA operates a number of UAVs, ranging from small tactical UAVs to MALE UAVs to HALE UAVs.[41] While virtually any PLA UAV could operate from China's SCS airfields, PLA Navy UAVs are the most likely to operate from the SCS outposts. Long-endurance UAVs can range the entire SCS from mainland China or Hainan Island airfields. However, most UAVs fly at relatively slow speeds. Operating long-endurance UAVs from the PLA's SCS outposts maximizes responsiveness and on-station time and allows the PLA to maintain LOS communications for more reliable control. As of mid-2020, UAV deployments to island-reef airfields at Fiery Cross, Subi, and Mischief Reefs had not been observed in commercial satellite imagery.

Several PLA UAVs can carry missiles for armed strike missions. However, in keeping with the PLA's informationized warfare operational concepts, UAVs launched from the SCS island-reef airfields more likely will be used for persistent, long-range ISR, especially in peacetime or the early stages of a conflict. Additionally, if satellite or other long-haul communications are lost, UAVs can establish an "airborne layer," acting as relays to reestablish communications links among the PLA's SCS outposts and with PLA Navy ships operating nearby.

[41] For excellent references on PLA UAVs, see Dan Gettinger, *The Drone Databook* (Annandale-on-Hudson: Center for the Study of the Drone at Bard College, 2019), 11-21, https://dronecenter.bard.edu/files/2019/10/CSD-Drone-Databook-Web.pdf, and Elsa Kania, *The PLA's Unmanned Aerial Systems* (Montgomery, AL: Air University, China Aerospace Studies Institute, 2018), https://www.airuniversity.af.edu/Portals/10/CASI/Books/PLAs_Unmanned_Aerial_Systems.pdf.

BZK-005 (Chang Ying) MALE UAV. The PLAAF and PLANAF have been operating the BZK-005 UAV since 2010. PLANAF BZK-005s routinely conduct overwater surveillance operations (see Figure 18).[42] In 2016, at least one BZK-005 deployed to Woody Island in the northern SCS.[43] This type of UAV is a likely candidate for deployment to the PLA Spratly Island outposts.

The BZK-005 is also known as the Chang Ying (长鹰) or "Long Eagle." This MALE UAV can purportedly operate for 40 hours at altitudes up to 7,000 meters (~23,000 feet). BZK-005 payloads may include a combination of EO/IR cameras, a SAR, an ELINT array, or a communications relay package. The BZK-005 UAV can be controlled through a LOS data link or SATCOM. This UAV can carry two air-to-surface weapons on hard-points under the fuselage for strikes against land targets.[44] A maritime strike capability has not yet been observed.

(JSDF Photo)

Figure 18. BZK-005 Over the East China Sea

"Predator-Class" MALE UAV/UCAV. Chinese defense companies produce a number of UAVs that are similar in appearance and performance to the US RQ-1 Predator ISR UAV or the weaponized MQ-9 Reaper unmanned combat aerial vehicle (UCAV). These Chinese UAVs/UCAVs all employ push-propellers and can be configured with air-to-surface weapons, EO/IR cameras, and SAR, as well as ELINT, EA, and communications relay packages. Like the BZK-005, these UAVs/UCAVs can be controlled through a LOS data link or SATCOM. This class of UAVs/UCAVs contains likely candidates for deployment to the SCS island-reefs in an ISR or strike role.

[42] Joint Staff, 推定中国機の東シナ海における飛行について [Presumed Chinese aircraft flying in the East China Sea], press release (Tokyo: Japanese Ministry of Defense, April 30, 2018), http://www.mod.go.jp/js/Press/press2018/press_pdf/p20180418_01.pdf.

[43] "An Accounting of China's Deployments to the Spratly Islands," *Asia Maritime Transparency Initiative*, May 9, 2018, https://amti.csis.org/accounting-chinas-deployments-spratly-islands/.

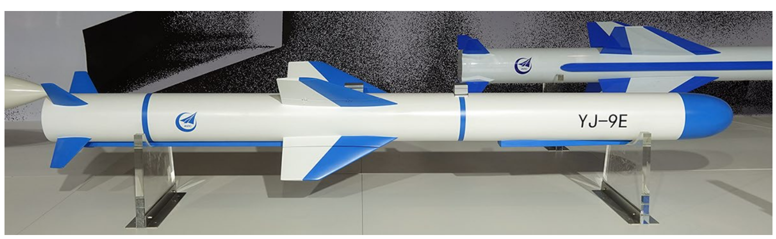
[44] "BZK-005C," 北京北航天宇长鹰无人机科技有限公司 [Beihang UAS Technology Co, Ltd.], accessed August 23, 2020, http://www.buaauas.com/product/gudingyi/66.html.

Since at least 2010, the PLAAF has been operating MALE UCAVs like the **GJ-1** and **GJ-2** made by the Aviation Industry Corporation of China (AVIC). "GJ" stands for "攻击" (gōngjī), or "attack." The export variant of these UAVs/UCAVs are the Wing Loong I and Wing Loong II, sometimes called the "翼龙" (yìlóng), meaning "pterodactyl." China exported Wing Loong-series UCAVs throughout Central, South, and Southwest Asia.[45] A variant of the Wing Loong I, the Wing Loong I-D, was introduced in 2016 with an improved wing design that significantly increases performance. The slightly larger GJ-2/Wing Loong II was also introduced in 2016 (see Figure 19).

(JHU/APL Photos)

Figure 19. Wing Loong I-D (Left) and GJ-2 (Right) UCAVs

The GJ-/Wing Loong-series UCAV can carry a wide variety of relatively light air-to-surface weapons for land attack. The larger GJ-2 and the Wing Loong-1D can also carry the YJ-9E anti-ship missile that can deliver a 30-kilogram (66-pound) warhead at ranges up to 25 kilometers (13.5 nautical miles) (see Figure 20). The YJ-9E warhead is large enough to sink smaller boats, but it probably is not large enough to substantially damage or destroy larger naval combatants.



(JHU/APL Photo)

Figure 20. YJ-9E Anti-Ship Missile

The China Aerospace Science and Technology Corporation (CASC) also produces CH-series UCAVs that are Predator-type drones. "CH" stands for "彩虹" (cǎihóng) or "rainbow." There is some evidence the PLAAF operates the CH-4, but China's

[45] The Wing Loong I UAV was reportedly exported to Egypt, Indonesia, Kazakhstan, Pakistan, Saudi Arabia, Serbia, Turkmenistan, and the United Arab Emirates (UAE). The Wing Loong II UAV was exported to the UAE. See Gettinger, *The Drone Databook*.

CH-series of UAVs have primarily been exported to South and Southwest Asia, as well as Africa.[46] In mid-2020, CASC announced a maritime version of the **CH-5 UCAV** (see Figure 21). This MALE UCAV is reportedly hardened against high temperatures, high humidity, and salt-air environments.[47] The maritime CH-5 as described by Chinese state media is ideally suited for future deployments to the PLA's SCS outposts. Performance parameters for select MALE UAVs/UCAVs appear in Table 2.

Table 2. PLA MALE UAV/UCAV Performance[48]

UAV UCAV	Length	Wingspan	External Payload	Hard-points	Max Speed	Max Ceiling	Endurance
BZK-005	10.4 m (34 ft)	18 m (59 ft)	150 kg (330 lb)	2	210 km/hr (113 kt)	8,000 m (26,000 ft)	40 hr
GJ-1 Wing Loong I	9 m (30 ft)	14 m (46 ft)	200 kg (441 lb)	2	280 km/hr (151 kt)	7,000 m (23,000 ft)	20 hr
Wing Loong I-D	8.7 m (29 ft)	17.6 m (58 ft)	400 kg (882 lb)	4	280 km/hr (151 kt)	7,500 m (24,600 ft)	35 hr
GJ-2 Wing Loong II	10.8 m (35 ft)	20.7 m (68 ft)	480 kg (1058 lb)	6	370 km/hr (200 kt)	9,000 m (29,500 ft)	20 hr
CH-5	11.3 m (37 ft)	21 m (69 ft)	480 kg (1058 lb)	6	300 km/hr (162 kt)	8,300 m (25,000 ft)	35 hr

[46] The CH-3 and CH-4 have been exported to Algeria, Egypt, Ethiopia, Indonesia, Iraq, Jordan, Myanmar, Nigeria, Pakistan, Saudi Arabia, Turkmenistan, UAE and Zambia. See Gettinger, *The Drone Databook*.

[47] Deng Xiaoci and Liu Xuanzun, "Maritime Version of China's CH-5 Drone Makes First Test Flight," *Global Times*, July, 16, 2020, https://www.globaltimes.cn/content/1194771.shtml.

[48] Data from "BZK-005C," 北京北航天宇长鹰无人机科技有限公司 [Beihang UAS Technology Co, Ltd.], "Wing Loong I UAS," "Wing Loong I-D UAS," "Wing Loong II UAS," trade brochures (中国航空工业集团公司 [Aviation Industry Corporation of China, Ltd.], 2018), as well as Deng and Liu, "Maritime Version of China's CH-5 Drone Makes First Test Flight."

(JHU/APL Photo)

Figure 21. CH-5 UCAV

Xianglong HALE UAV. The PLA began operating the Xianglong (翔龙), or "Soaring Dragon," HALE UAV in 2017. While this high-altitude UAV is in service with the PLAAF, it is not clear whether the Xianglong has been acquired by the PLANAF. A Xianglong UAV appears to have participated in a joint air force-navy exercise, but there is no other evidence that the PLANAF operates this UAV as of mid-2020.

The Xianglong HALE UAV appears to be used exclusively for ISR or communications relay and does not carry weapons. This UAV has a unique, joined tandem wing design and may incorporate low-observable stealth technologies.[49] The Xianglong has been touted as similar to the US RQ-4 Global Hawk UAV. However, while the Xianglong's fuselage is roughly the same size, the Global Hawk can carry a 1,360-kilogram (3,000-pound) payload for more than 34 hours. [50] The Xianglong has half the payload capacity—650 kilograms (1,433 pounds)—and less than one-third the endurance, a relatively short 10 hours. A Xianglong UAV operating over Fiery Cross Reef at its maximum altitude of 18,000 meters (59,000 feet) provides surface coverage for most of the southern SCS (see Figure 22).

[49] The Xianglong's designation is unclear. It has been called the EA-03 but also has been referred to as the WZ-7 or WZ-9. "WZ" (wú zhēn) means "no detection" and is a designator typically given to stealthy UAVs.

[50] "RQ-4 Global Hawk," US Air Force Fact Sheet, October 2014, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104516/rq-4-global-hawk/.

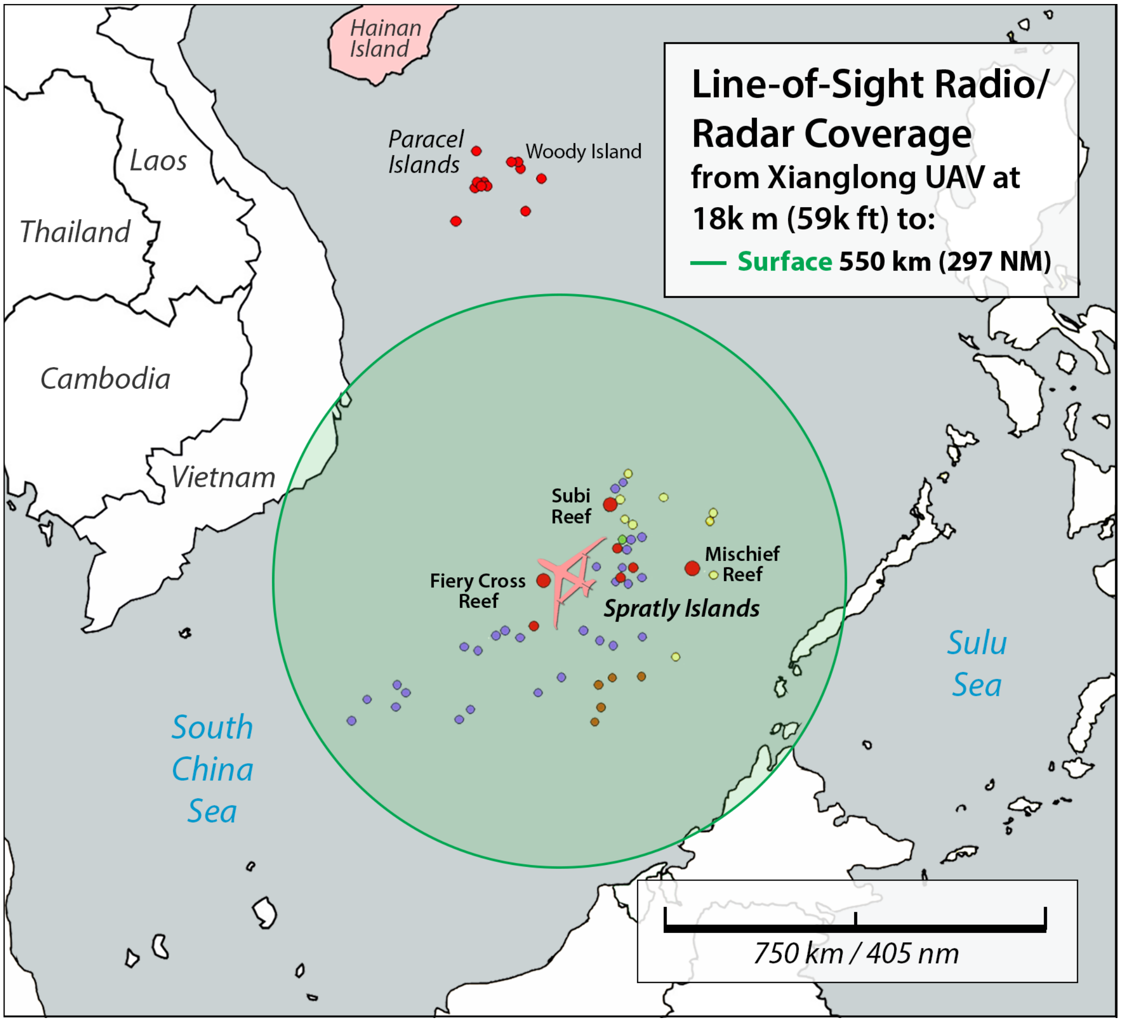


Figure 22. Xianglong UAV SCS LOS Coverage

In 2018, commercial imagery spotted Xianglong UAVs deployed to three different Chinese airfields on the Sino-Indian border, the North Korean border, and at a PLANAF airfield on Hainan Island.[51] The 2018 deployment to Hainan's Lingshui airfield reportedly involved PLANAF trials integrating the Xianglong UAV with a PLANAF KJ-500 AEW&C aircraft, a KQ-200 ASW/MARPAT aircraft, and a Y-9JB SIGINT/ELINT aircraft. This activity was apparently part of an ISR and targeting exercise involving the Southern Theater PLANAF special mission aircraft division.[52]

[51] Christopher Biggers, "Xianglong UAVs Spotted on China's Hainan Island," *Jane's Defence Weekly*, March 21, 2018, https://janes.ihs.com/Janes/Display/FG_889553-JDW.

[52] "南海舰队试用翔龙无人侦察机" [South Sea Fleet Tests Xiang Long Unmanned Reconnaissance Aerial Vehicle], *Sina*, April 18, 2018, http://mil.news.sina.com.cn/jssd/2018-04-18/doc-ifzihnep2775237.shtml, cited in Elsa Kania, *The PLA's Unmanned Aerial Systems,* 17.

Future UAVs. Chinese defense companies have an exceedingly wide array of UAVs in development or available for export that may eventually be acquired by the PLA and deployed to the SCS island-reefs. These include experimental designs such as the Chinese Electronic Technology Group Corporation (CETC) JY-300 "flying radar," featuring a fuselage conformal SAR. Helicopter drone designs include AVIC's AV500W UCAV with a claimed 8-hour endurance and 100 kilometer (54 nautical mile) LOS control radius (see Figure 23). The PLA Navy previously operated a much shorter range drone, the Austrian-built S-100 helicopter UAV, from its ships (see Figure 24).[53]

(JHU/APL Photos)

Figure 23. JY-300 Flying Radar (Left) and AV500W UCAV (Right)

(JSDF Photo)

Figure 24. Probable S-100 UAV Operating from PLA Navy Type-054A Frigate

[53] Joint Staff, 中国海軍艦艇の動向について [Trends in Chinese Naval Vessels], press release (Tokyo: Japanese Ministry of Defense, May 15, 2012), https://www.mod.go.jp/js/Press/press2012/press_pdf/p20120515.pdf.

The GJ-11 Sharp Sword UCAV was unveiled in China's 2019 National Day parade.[54] The flying wing design of the GJ-11 appears very similar to the US Navy X-47B UCAV. As of mid-2020, there were no indications the GJ-11 UCAV was operational with the PLAAF or PLANAF. Future operations of armed, unmanned aircraft, such as the GJ-11, from China's SCS bases are likely several years away.

Aerostats

Aerostats are a reliable and relatively inexpensive way to elevate communications equipment and ISR sensors to extend ranges well beyond the surface horizon. In November 2019, commercial satellite imagery noted a tethered aerostat flying over Mischief Reef.[55] The CETC aerostat in Figure 25 is described as a "Low-Altitude Remote Sensing Data Acquisition and Processing System." Whether incorporated into routine operations or deployed to the island-reefs to compensate for damage inflicted on the outposts, aerostats or balloons could perpetually stay aloft over China's SCS island-reefs to extend ISR ranges and relay communications among the island-reefs and surface ships.

(JHU/APL Photo)

Figure 25. CETC Aerostat

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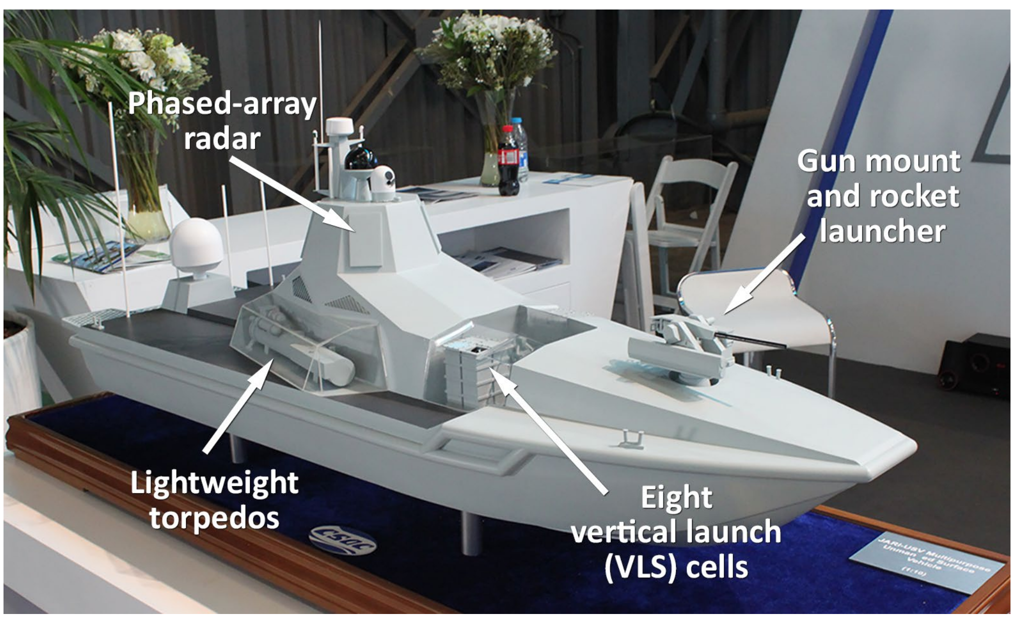
[54] Yang Sheng and Liu Xuanzun, "Chinese Military Commissions GJ-11 Stealth Attack Drone," *Global Times*, October 1, 2019, https://www.globaltimes.cn/content/1165939.shtml

[55] Ankit Panda, "Imagery Suggests China Deployed Surveillance Aerostat to Mischief Reef in the South China Sea," *Diplomat*, December 3, 2019, https://thediplomat.com/2019/12/imagery-suggests-china-deployed-surveillance-aerostat-to-mischief-reef-in-south-china-sea/

Unmanned Surface Vehicles

Chinese defense research institutes and shipbuilders are actively experimenting with USVs and self-controlled autonomous surface vessels (ASVs). Chinese state-owned enterprises and private companies promote a variety of USVs and ASVs in different shapes and sizes for military use, environmental monitoring, and civilian security surveillance. Foreign and domestic arms shows market a wide range of Chinese USVs for export. As of mid-2020, however, there were no indications the PLA incorporated combat USVs into its operational forces.

A division of the China Shipbuilding Industry Corporation (CSIC), the Jiangsu Automation Research Institute (JARI), also known as the CSIC 716th Research Institute (RI), introduced an armed USV called the JARI. The patrol-craft-size JARI is 15 meters (49 feet) in length, displacing around 20 tons (see Figure 26). In August 2019, the 716th RI reportedly launched a JARI USV, declaring that the unmanned ship was "combat ready."[56] While a statement from CSIC indicated that the USV would undergo testing to conduct autonomous operations and coordinated USV swarming, there are no outward indications that these experiments will lead to the PLA Navy adopting this particular USV.



(JHU/APL Photo)

Figure 26. JARI USV

[56] Liu Xuanzun, "China Launches World-Leading Unmanned Ship," *Global Times*, August 22, 2019, http://www.globaltimes.cn/content/1162320.shtml.

Smaller unmanned or autonomous craft, such as wave gliders, may already be operating from the PLA's SCS bases. Wave gliders use wave power and solar energy to propel themselves through waters at slow speeds on extended patrols, usually to collect environmental data. Wave gliders could also be configured to conduct persistent ISR such as acoustic or ELINT collection.

Unmanned Underwater Vehicles

As with USVs, Chinese research institutes are actively experimenting with UUV and autonomous underwater vehicle (AUV) technology. To date, most of this experimentation appears to be directed at matching capabilities with Western UUV/AUV technology. Underwater robotic testing focused on deployments over long ranges, months-long endurance, and operations to the deepest depths of the ocean.[57] While there are reports of PLA involvement in UUV/AUV research, there are few publically available indications that the PLA incorporated UUVs or AUVs into its combat force structure as of mid-2020. As with USVs, the PLA is likely operating UUVs to collect underwater environmental data and hydro-acoustic data to enhance sonar operation. To date, there have been no indications that UUVs operated from China's SCS bases, but that is likely to change in the near future.

The PLA unexpectedly introduced what may be a large-displacement UUV (LDUUV), the HSU001, in China's 2019 National Day parade.[58] The HSU001 is similar in size and appearance to the US Navy's Snakehead LDUUV, which is a submarine-launched, long-endurance UUV.[59] Other than the HSU001 appearance in the parade, there are no other publically available indications this UUV is currently operational with the PLA Navy. There is little solid information about the HSU001's origins, missions, or capabilities. The UUV may have been developed at the Harbin Institute of Technology, a university located among a cluster of Chinese research institutes in China's northern Shenyang region that focus on underwater robotics.[60] Based on the HSU001's

[57] Feng, "这些神级水下机器人"出生"在沈阳" [These Magical Underwater Robots Were "Born" in Shenyang], 中国科学院 [Chinese Academy of Sciences], November 10, 2017, http://www.cas.cn/kx/kpwz/201711/t20171113_4621582.shtml.

[58] Li Yibo, "China Exhibits Advanced Drones, Unmanned Underwater Vehicles in Military Parade," *Xinhau*, October 1, 2019, http://www.xinhuanet.com/english/2019-10/01/c_138439078_6.htm.

[59] "NAVSEA to Solicit Industry for Large Displacement Unmanned Underwater Vehicle (LDUUV)," Defense Systems Journal, September 16, 2019, https://www.dsjournal.com/2019/09/16/navsea-to-solicit-industry-for-large-displacement-unmanned-underwater-vehicle-lduuv/

[60] By78, "Commemorative Model of HSU001," *Chinese Unmanned Underwater Vehicles, SinoDefenceForum* (blog), December 13, 2019, https://www.sinodefenceforum.com/t/chinese-unmanned-underwater-vehicles-uuv.7805/page-6. The plaque on the model says "哈爾濱工業大學研制" [Harbin Institute of Technology (HIT) Developed/Manufactured] and bears the HIT seal. Harbin is also the home of the Harbin

similarity to the Snakehead LDUUV, there is speculation that this Chinese UUV is optimized for long-range ISR, infiltration, or mine-countermeasures missions.[61]

Chinese claims of technological advancement using underwater drones are often exaggerated or misinterpreted by media.[62] The Chinese Academy of Sciences (CAS) touted “cluster observations” (集群观测) by twelve “Sea Wing” (海翼) underwater gliders gathering undersea environmental data.[63] While one might assume that these were autonomous operations coordinated in real time, there are no indications that the Chinese “cluster observations” involved UUVs communicating with each other, operating collaboratively, or exchanging data. These experiments were most likely simply clusters of UUVs operating independently on predetermined routes in predetermined areas to cover large ocean areas.

Conclusions

The Chinese-held island-reef bases offer the PLA both increased range and flight time to conduct manned and unmanned surveillance. Figure 27 depicts how the location of China’s SCS airfields translates into range and on-station time for aircraft and UAVs. Platform endurance is given as 80–100 percent of advertised maximum endurance.

A Y-9 special mission aircraft with a cruising speed of 550 kilometers per hour (297 knots) can operate for 5–8 hours up to 750 kilometers (400 nautical miles) from the PLA SCS outposts in areas that may include the Sulu Sea. Y-9s can patrol for 3–5 hours at the far reaches of the SCS and in the Gulf of Thailand or the Celebes Sea. From SCS airfields, a Y-9 with an operational range of 5,000 kilometers (2,700 nautical miles) can circumnavigate the island of Borneo, surveilling the southern approaches to the SCS from the Strait of Malacca to the Java, Celebes, and Sulu Seas. Such patrols would not be possible from Chinese mainland airfields that add an additional 2,000 kilometers (1,080 nautical miles) to the flight.

Engineering University, a PLA affiliated research university and the CAS Shenyang Institute of Automation, both of which have established UUV development programs.

[61] David Strachan, “China Enters the UUV Fray,” *Diplomat*, November 22, 2019, https://thediplomat.com/2019/11/china-enters-the-uuv-fray/

[62] Stephen Chen, “Why Beijing is Speeding Up Underwater Drone Tests in the South China Sea,” *South China Morning Post,* July 26, 2017, https://www.scmp.com/news/china/policies-politics/article/2103941/why-beijing-speeding-underwater-drone-tests-south-china

[63] Shenyang Institute of Automation, “’海翼’水下滑翔机完成印度洋集群观测应用” [‘Sea Wing’ Underwater Glider Completes Indian Ocean Cluster Observation Application], 中国科学院 [Chinese Academy of Sciences], March 16, 2020, http://www.cas.cn/zkyzs/2020/03/241/yxdt/202003/t20200317_4737887.shtml

Similarly, UAV and UCAV flights originating from SCS island-reef airfields benefit in terms of range and on-station time. While maximum speeds are given in Table 2 of the earlier UAV section, propeller-driven UAVs realize ultra-long endurance times through relatively slow, efficient cruising speeds around 150 kilometers per hour (81 knots). Using this speed for calculations, a MALE UAV/UCAV like the BZK-005 or Wing Loong I-D can operate up to 750 kilometers (400 nautical miles) from the PLA SCS outposts for 18–28 hours and 10–18 hours at twice that range. A UCAV like the PLA's G-2 at cruising speed has a round-trip reach out to 1,500 kilometers (810 nautical miles), allowing it to range the Gulf of Thailand, Strait of Malacca, or Celebes Sea from China's SCS outposts.

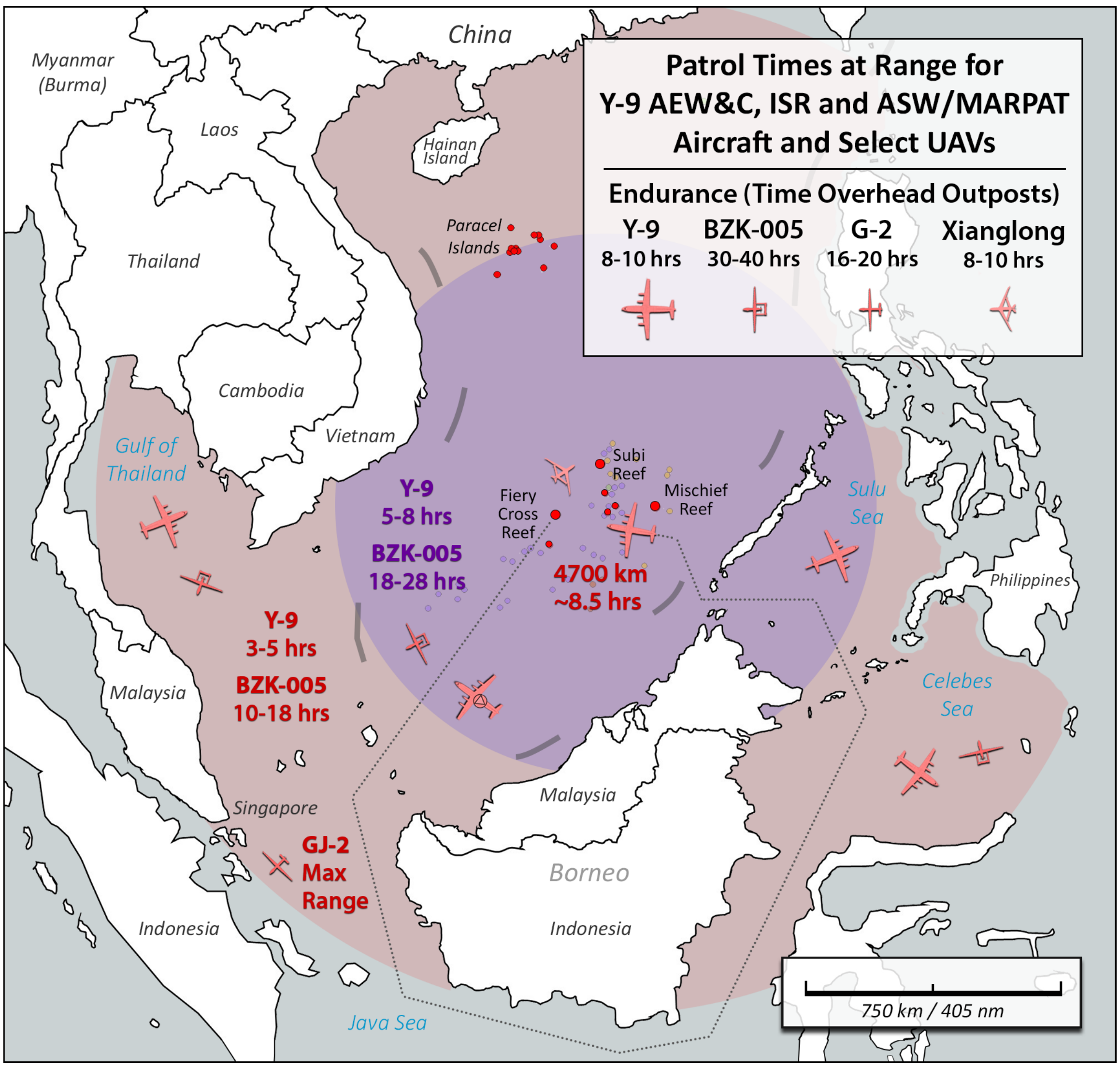


Figure 27. Y-9 Special Mission Aircraft and UAV/UCAV Ranges

It is likely that UAVs and UCAVs will figure prominently into future PLA operations from their SCS island-reef bases. The relatively remote location of China's SCS island-reef airfields combined with airfield infrastructure, hangers, long runways, and communications capabilities make the PLA outposts ideally suited for future UAV/UCAV experimentation and operations, including integration exercises with manned aircraft and large naval formations. China's SCS outposts provide fuel and logistics, as well as LOS communications, allowing the PLA to control and operate unmanned systems deep in the SCS even in a SATCOM-denied environment. A number of Chinese logistics UAVs are also in development that could be used to routinely deliver cargo to the remote SCS island-reefs.

Special mission aircraft and unmanned systems deployed to China's SCS island-reefs will be important information-control elements employed in conjunction with other island-reef and ship-based information power capabilities. As the PLA began its large-scale roll-out of different Y-9 special mission aircraft in 2018, a Chinese state television profile made a bold claim. With aircraft like the KJ-500, "the air force can increase air defense efficiency by 15 to 30 times, increase the number of enemy aircraft intercepted and shot down by 35 to 150 percent, and reduce the number of enemy aircraft attacks on rear areas by more than half."[64] While this may be an exaggeration, special mission aircraft are significant informationized warfare force multipliers for the Chinese military in the SCS.

PLA investments in a diverse array of special mission aircraft and unmanned systems demonstrates a Chinese informationized warfare strategy that emphasizes battlespace information control. These examples of flexible C3 and ISR capabilities represent layers of active and passive systems—redundancies that enable the PLA's information-centric operational concepts. These capabilities will be synchronized with PLA land-based and ship-based information power capabilities to create a complex, integrated command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) system of systems. Countering this complex Chinese C4ISR system of systems will require an opposing integrated system of systems approach that integrates both kinetic and non-kinetic means to deny the PLA its designs to gain and maintain battlespace information superiority.

[64] "运-9 到底有多厉害？" [How Powerful is the Y-9?], *CCTV.com*.

Appendix A. Sources and Methods

Observations and analysis of the Chinese SCS outposts in these MILCAP studies rely on commercial satellite imagery licensed to JHU/APL and collected by the Maxar/DigitalGlobe Inc. WorldView-3 satellite (see Table 2). WorldView-3 can collect images up to 30-centimeters resolution, which translates to image quality between 5.0 and 6.0 on the National Imagery Interpretation Rating Scale (NIIRS).[65] For these studies, software like Google Earth Pro and Adobe Photoshop were used to interpret imagery, measure features, and adjust image color and balance. These images were not subject to any special processing or proprietary enhancements.

Table 3. DigitalGlobe Inc. WorldView-3 Satellite Imagery Details

Island-Reef	Location	Date	DigitalGlobe Image ID
Fiery Cross Reef	09°33′00″ N, 112°53′25″ E	June 14, 2018	104001003C49BB00
Subi Reef	10°55′22″ N, 114°05′04″ E	June 19, 2018	104001003E841300
Mischief Reef	09°54′10″ N, 115°32′13″ E	June 19, 2018	104001003D964F00

Reference images published in these studies cover hundreds of square meters, which necessarily obscures many specific features used in making assessments. Zoomed-in examples of details available in these satellite images are shown in Figure 28. The dots made up of only a few pixels in Figure 28(A) cannot be readily identified. However, their location on the basketball court leads to a conclusion that these may be personnel. As shown in Figure 28(B), observing shadows and other features may reveal structures such as a common HF dipole antennae, even if the fine-gauge wires cannot be seen in the image. Shadow length may be translated into object height using satellite image metadata and simple trigonometry. Figure 28(C) is an example that indicates the likely connection between two widely separated troposcatter terminals based on antenna pointing angles. Figure 28(D) demonstrates that positive identification of detailed features may be possible with a much higher quality reference image. The PLA Navy Type 056 corvette in the satellite image may be an anti-submarine warfare variant (Type 056A) based on the light colored feature seen where the door for a towed sonar array should be located.[66]

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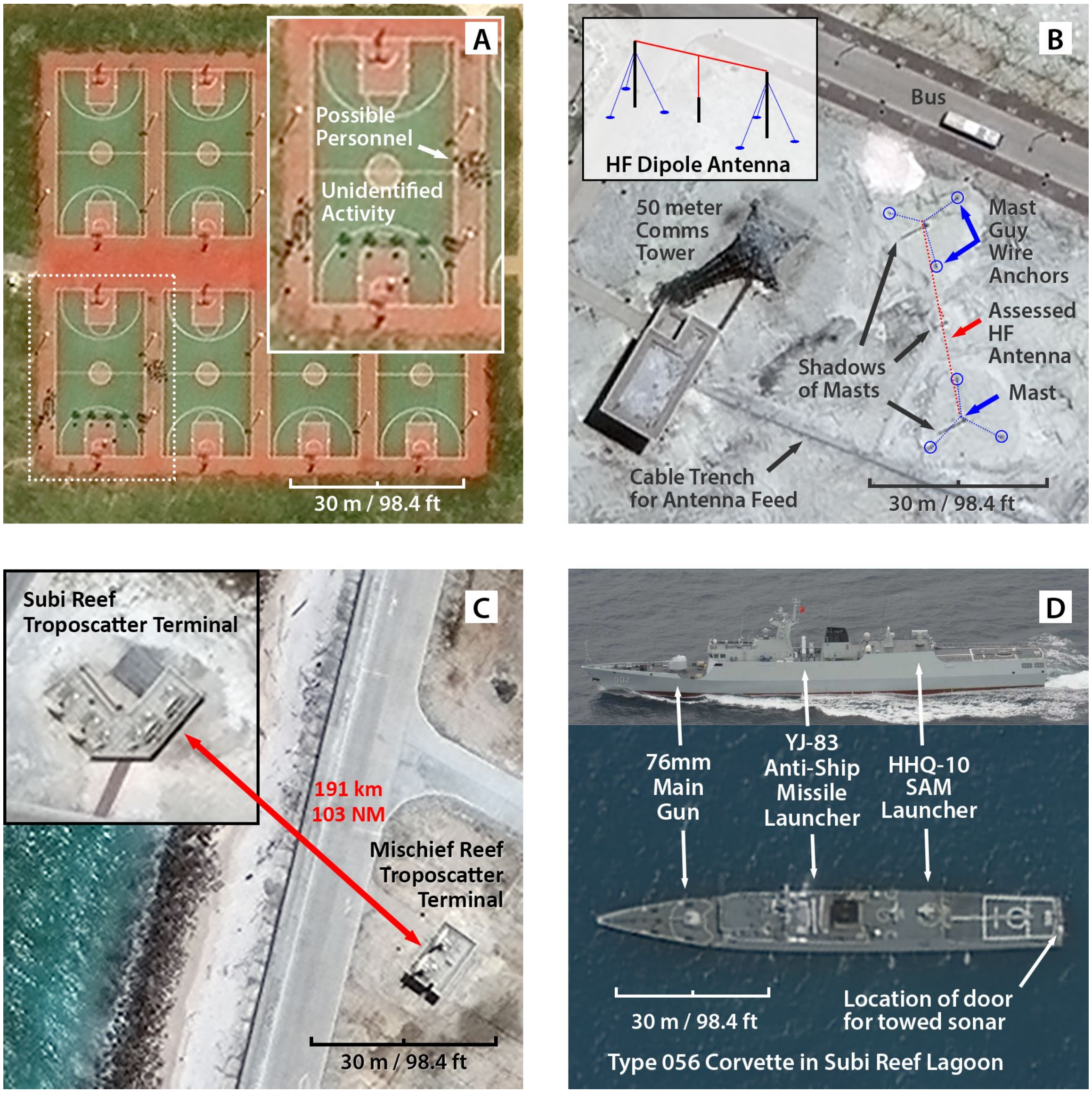
[65] Leigh Harrington, David Blanchard, James Salacain, Stephen Smith, and Philip Amanik, *General Image Quality Equation; GIQE version 5*, (Washington, DC: National Geospatial-Intelligence Agency (NGA), 2015), https://gwg.nga.mil/ntb/baseline/docs/GIQE-5_for_Public_Release.pdf.

[66] See close-up images of the towed array door in "'Sanmenxia,' First Type 056A ASW Corvette (Jiangdao Class), Commissioned in Chinese Navy (PLAN)," *Navy Recognition*, November 19, 2014, accessed July 1, 2020, http://navyrecognition.com/index.php?option=com_content&view= article&id=2189.



(Images © 2020 Maxar/DigitalGlobe, Inc. Photograph of ship courtesy of Japan Self Defense Force)

Figure 28. Detailed Image Examples. (A) Mischief Reef Basketball Courts, (B) Mischief Reef HF Antenna, (C) Troposcatter Terminals, (D) Type 056 Frigate

Publicly accessible satellite imagery, available on Google Earth or from organizations like the Asia Maritime Transparency Initiative, provides historical images that may show changes to island-reef features over time. Official or semi-official Chinese sources discussing military capabilities on the SCS outposts complement imagery analysis and help qualify imagery observations. Where appropriate, these studies also reference secondary sources such as credible media reporting on China's SCS island-reefs or public U.S. government statements about PLA capabilities in the SCS.

Appendix B. South China Sea Maritime Territorial Claims

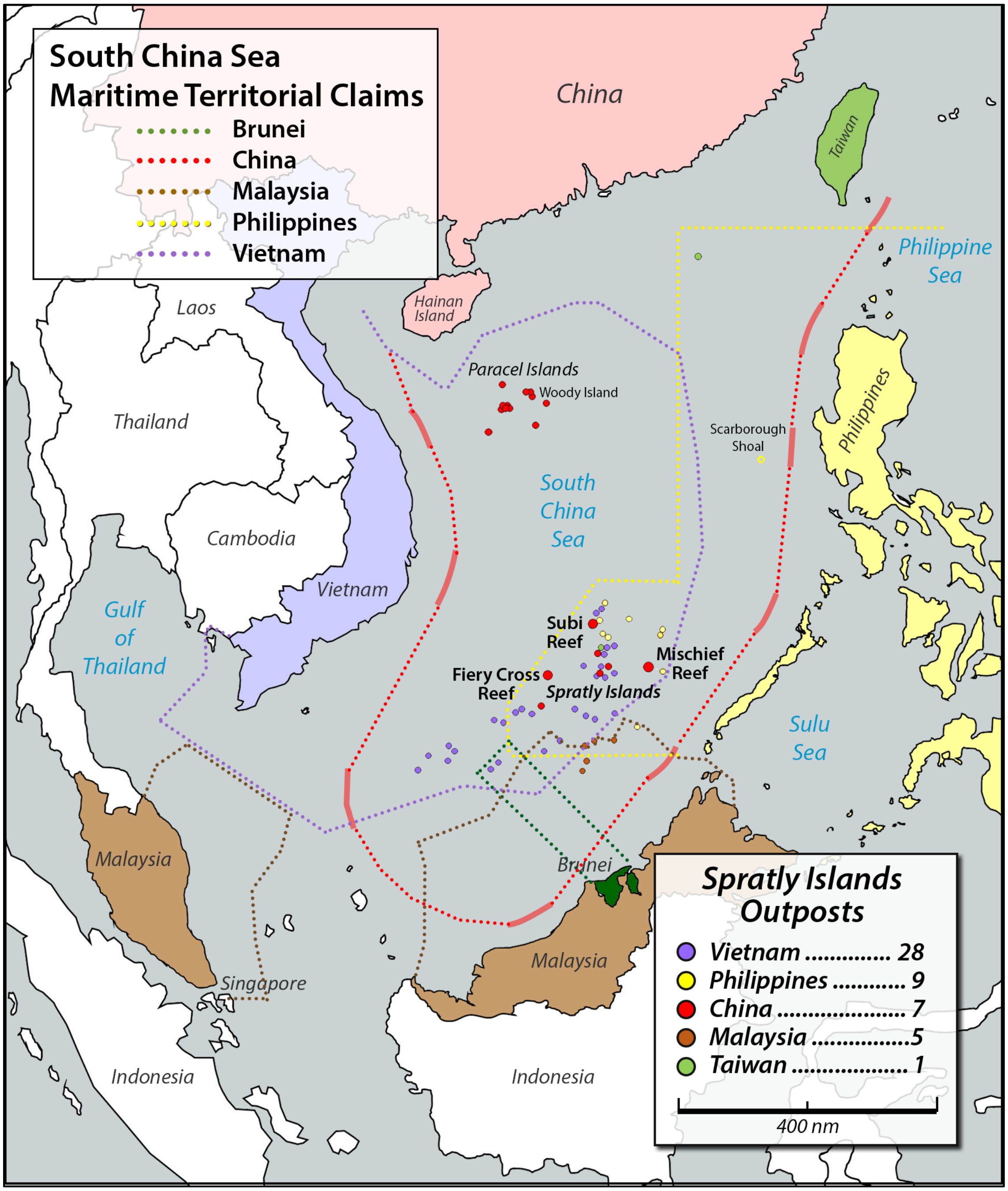
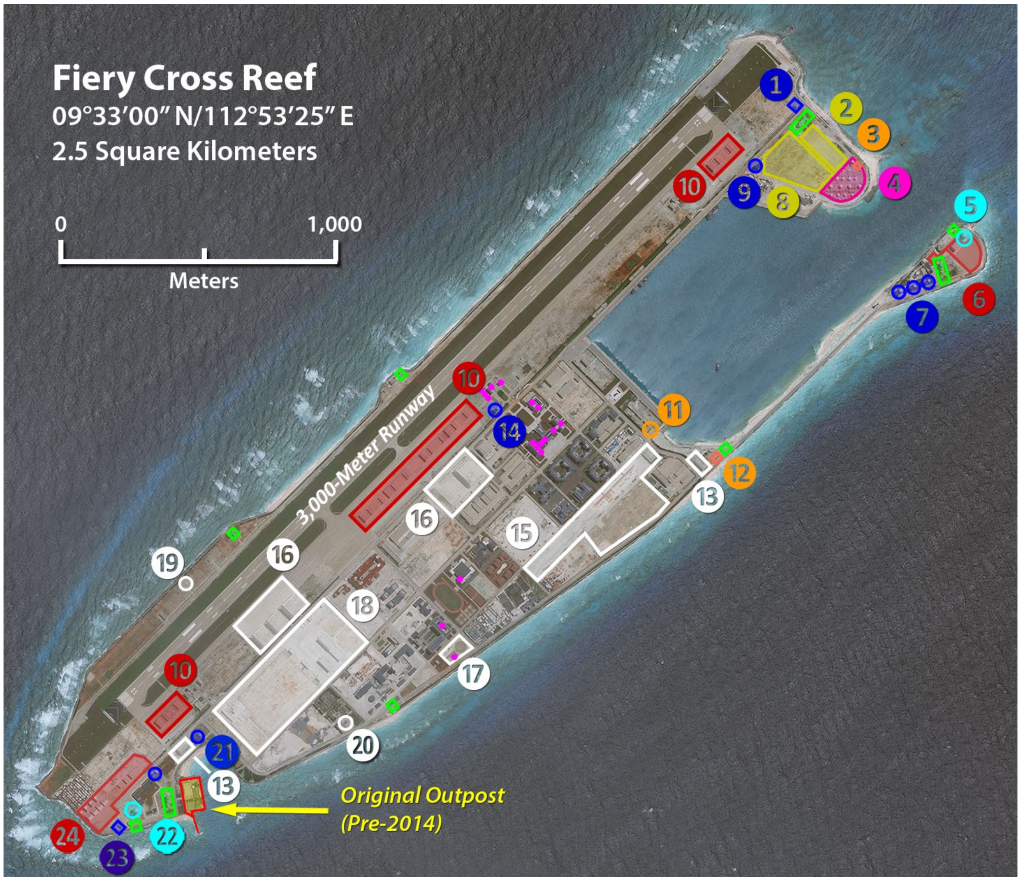


Figure 29. South China Sea Maritime Territorial Claims

Appendix C. Island-Reef Capabilities Overview Graphics



Satellite Communications (SATCOM)
- 4. SATCOM Earth Station
- • Individual SATCOM Dishes

High-Frequency (HF) Communications
- 2. HF Monopole Array (Possible Signals Intelligence)
- 8. HF Antenna Array

Inter-Island Communications
- 3. Troposcatter Station North (to Subi Reef)
- 11. VHF/4G LTE Cell Tower
- 12. Troposcatter Station East (to Johnson/Cuarteron)

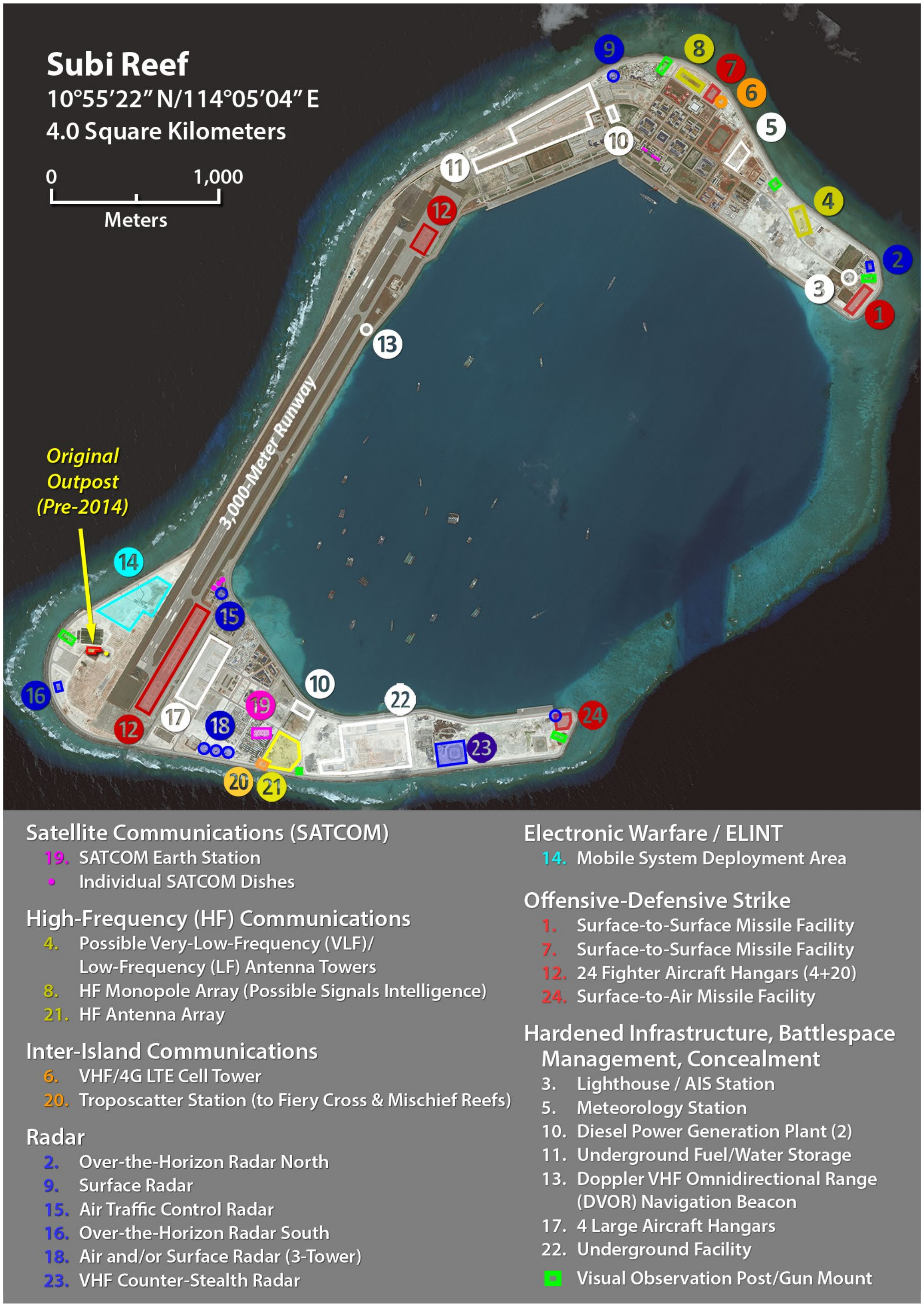
Radar
- 1. Over-the-Horizon Radar North
- 7. Air or Surface Radar (3-Tower)
- 9. Air or Surface Radar
- 14. Air Traffic Control Radar
- 21. Air Target Tracking/Air Surveillance Radar (2)
- 23. Over-the-Horizon Radar South

Electronic Intelligence (ELINT)
- 5. Probable ELINT Array North
- 22. Probable ELINT Array South

Offensive-Defensive Strike
- 6. Surface-to-Surface Missile Facility
- 10. 24 Fighter Aircraft Hangars (4+16+4)
- 24. Surface-to-Air Missile Facility

Hardened Infrastructure, Battlespace Management, Concealment
- 13. Diesel Power Generator Plant (2)
- 15. Underground Fuel/Water Storage
- 16. 4 Large Aircraft Hangars (1+3)
- 17. Meteorology Station
- 18. Underground Facility
- 19. Doppler VHF Omnidirectional Range (DVOR) Navigation Beacon
- 20. Lighthouse / AIS Station
- ▪ Visual Observation Post/Gun Mount

Figure 30. Fiery Cross Reef Overview



(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 31. Subi Reef Overview

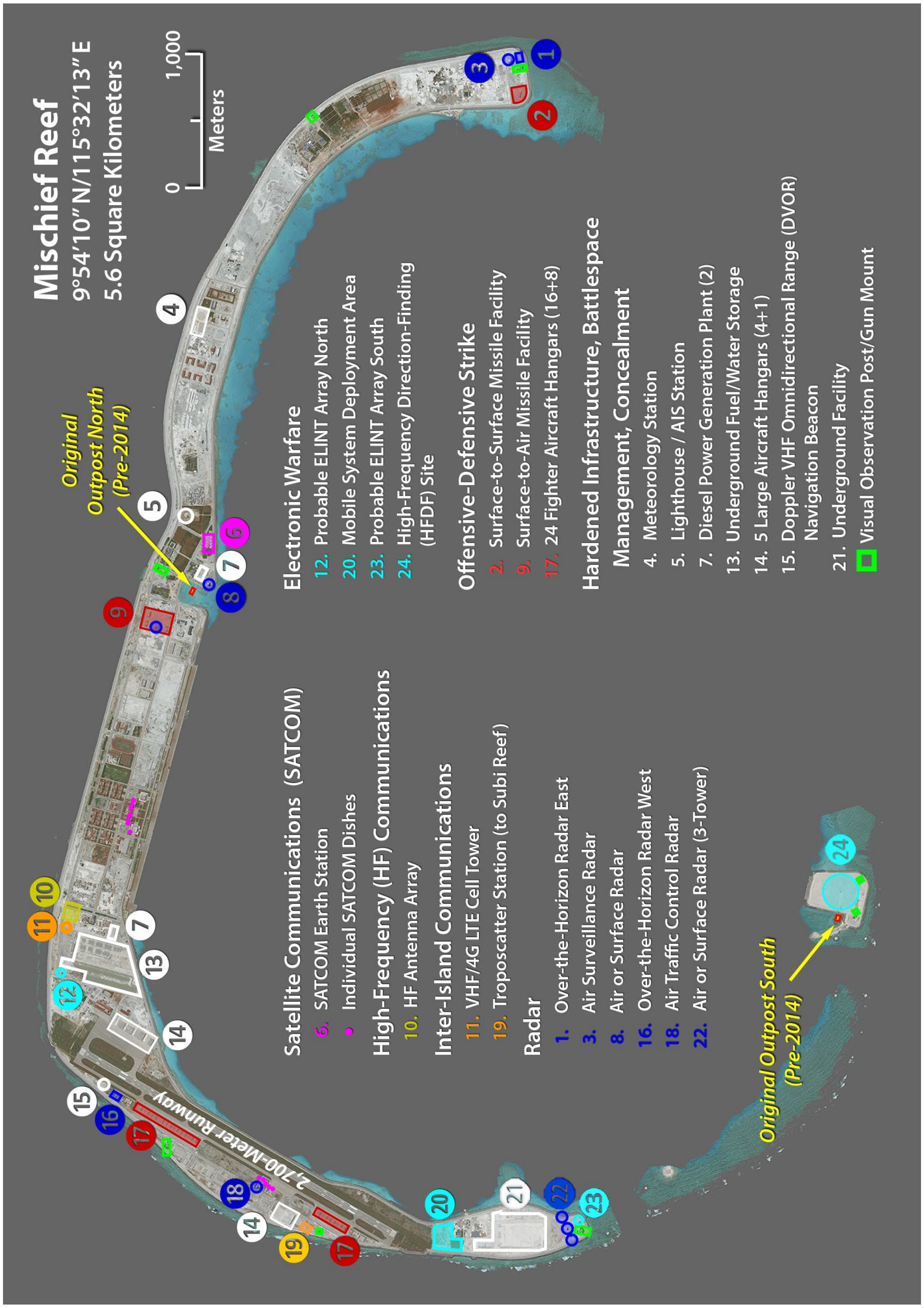


Figure 32. Mischief Reef Overview

Appendix D. Definitions and Abbreviations

AIS—Automatic identification system; tracking system used by large ships

4G LTE—Fourth-generation long-term evolution; cellular communications

ASCM—Anti-ship cruise missile

C4—Command, control, communications, and computers. Sometimes rendered C3, dropping "computers" or C2, "command and control"

C4ISR—Command, control, communications, computers, intelligence, surveillance, and reconnaissance. Sometimes C5ISR or C5ISRT, including "cyber" and "targeting"

CCD—Camouflage, concealment, and deception

ELINT—Electronic intelligence

EMS—Electromagnetic spectrum; common frequency bands are shown in Table 3

Table 4. Radio and Radar Frequency Bands

ITU Radio Bands	Band Name	Frequency Range	IEEE Radar Bands	Frequency Range
VLF	Very-low frequency	3-30 kHz		
LF	Low frequency	30-300 kHz		
MF	Medium frequency	300-3000 kHz		
HF	High frequency	3-30 MHz		
VHF	Very-high frequency	30-300 MHz	VHF	30-300 MHz
UHF	Ultra-high frequency	300-3000 MHz	UHF	300-1000 MHz
			L	1-2 GHz
			S	2-4 GHz
SHF	Super-high frequency	3-30 GHz	C	4-8 GHz
			X	8-12 GHz
			Ku	12-18 GHz
			K	18-27 GHz
			Ka	27-40 GHz
EHF	Extremely-high frequency	30-300 GHz		

EW—Electronic warfare

HFDF—High-frequency direction finding

Information power—信息力 (*xìnxī lì*)—A Chinese term referring to the capability of a military force to achieve information superiority, ensuring the use of information for friendly forces while simultaneously denying its use to adversary forces

Informationized warfare—信息化作战 (*xìnxī huà zuòzhàn*)—The prevailing "form of war" (战争形态, *zhànzhēng xíngtài*) in Chinese military theory

Island-reef—岛礁 (*dǎo jiāo*)—A Chinese term for an islet or an island of sand that has built up on a reef. China's military outposts in the Spratly Island group were formerly rocks or high-tide features that do not have the international legal status of island that might otherwise define territorial waters or an exclusive economic zone

ISR—Intelligence, surveillance, and reconnaissance

PLA—People's Liberation Army; Refers to the entire Chinese military

PLAAF—People's Liberation Army Air Force

PLAN—People's Liberation Army Navy

PLANAF—People's Liberation Army Navy Air Force

PNT—Positioning, navigation, and timing

SATCOM—Satellite communications

SAM—Surface-to-air missile

SCS—South China Sea

SoS—System-of-systems

Southern Theater—One of five PLA theater commands created in the 2016 Chinese military reorganization. Area of responsibility includes southern China, Hainan Island, the SCS, and Paracel and Spratly island-reef bases

SSF—PLA Strategic Support Force

SSM—Surface-to-surface missile

Troposcatter— Troposcatter or tropospheric communications are microwave signals, generally above five hundred megahertz, scattered by dust and water vapor in the atmosphere, allowing for over-the-horizon communication links

UAV—Unmanned aerial vehicle

USV—Unmanned surface vehicle

UUV—Unmanned underwater vehicle

About the Author

J. Michael Dahm is a senior national security researcher at the Johns Hopkins University Applied Physics Laboratory where he focuses on foreign military capabilities, operational concepts, and technologies. Before joining JHU/APL, he served as a US naval intelligence officer for over 25 years. His most recent assignments included senior analyst in the USPACOM China Strategic Focus Group, assistant naval attaché at the US embassy in Beijing, China, and senior naval intelligence officer for China at the Office of Naval Intelligence.

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