

SOUTH CHINA SEA MILITARY CAPABILITY SERIES

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



INTRODUCTION TO SOUTH CHINA SEA MILITARY CAPABILITY STUDIES

J. Michael Dahm

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South China Sea Military Capability Series Studies

These military capability (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. In 2014, a massive project built artificial islands atop the seven Chinese-held reefs in the Spratly Islands. Construction on the island-reefs was substantially complete by 2018. The seven Chinese outposts have become significant People’s Liberation Army (PLA) bases that will enhance future Chinese military operations in the South China Sea (SCS), an area where Beijing has disputed territorial claims (See Appendix B). The three largest Chinese island-reefs—Fiery Cross, Subi, and Mischief Reefs—represent 12 kilometers of reclaimed land. The four smaller outposts—Cuarteron, Gaven, Hughes, and Johnson Reefs—taken together make up about half a square kilometer of reclaimed land. The relative size of the island-reefs is shown in Figure 1.¹

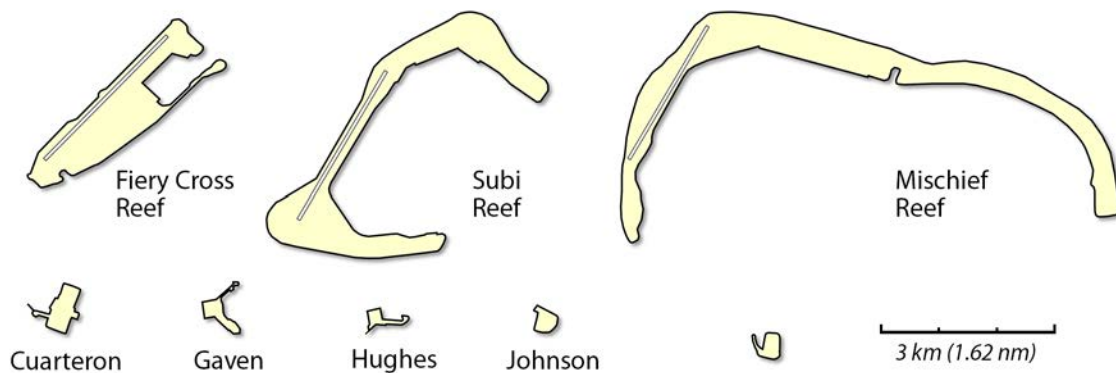


Figure 1. Relative Sizes of Chinese-Held Island-Reefs

The geopolitics in the SCS are as complex as the operational challenges that the PLA might create for any military competitor operating in the region. China has claimed sovereignty over almost all of the SCS within its “nine-dash line.” The seven Chinese outposts are interspersed with more than sixty habitable islands, island-reefs, and platforms largely built on underwater features. Vietnam, Malaysia, Taiwan, and the Philippines have claims to different parts of the SCS, including the Chinese-occupied island-reefs (Figure 2). These competitors also maintain a military presence on their island-reefs. However, the combined forces of the four nations’ in the SCS pale in comparison to PLA forces deployed on its massive artificial islands.

¹ Throughout this series, these artificial land masses, which are not recognized in international law as islands, are referred to as SCS outposts or by the Chinese term, “island-reef” (岛礁) that refers to an islet composed of rock, sand or coral that has built up on a reef.

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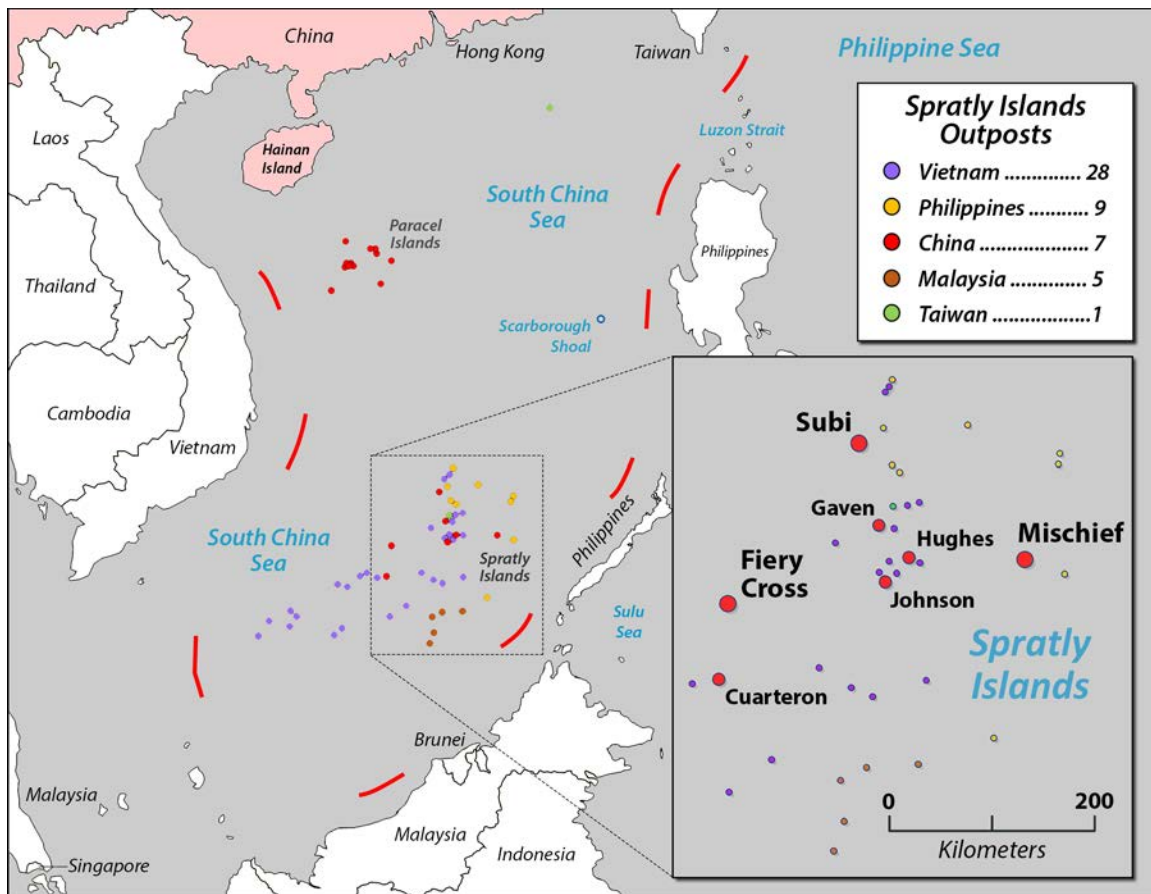


Figure 2. SCS Occupied Features

The size of the Chinese artificial islands is generally underappreciated; some military analysts assert that infrastructure and military capabilities might be wiped away in a single missile strike. Figure 3 shows the size of two of the SCS island-reefs compared to the Washington, DC area. The interior lagoon of Mischief Reef encompasses an area from Arlington National Cemetery to Capitol Hill. Fiery Cross Reef is approximately the same size as Joint Base Anacostia-Bolling or the DC National Airport complex.

The relative compactness of the Chinese SCS outposts makes them an attractive case study. Each island-reef, where all base facilities are co-located, may be captured in a single satellite image. On the Chinese mainland, radars and communications facilities may be scattered far from airfields and port facilities. See Appendix A for notes on sources and analytic methods.

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(Image © 2020 Google Earth/CNES/Airbus)

Figure 3. Size Comparison of Mischief and Fiery Cross Reefs

An examination of military capabilities on China's island-reefs reveals the PLA's informationized warfare strategy. The Chinese term informationized warfare (信息化作战) may be translated literally as "warfare transformed by information." Information power (信息力) is the operational expression of informationized warfare and is the first among the basic elements of Chinese operational-level power.² According to Chinese military doctrine, information power is more prominent than

² Chinese Academy of Military Sciences, 战役学 [Science of Campaigns], ed. Zhang Yuliang et al. (Beijing: National Defense University Press, 2006), 24.

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the industrial-age warfare elements of firepower or maneuver. The PLA's overarching focus on achieving battlespace information superiority as a tactical, operational, and strategic requirement cannot be overstated.

In keeping with China's informationized warfare operational concepts, the primary purpose of China's SCS bases is not to generate conventional military power but to facilitate information superiority with substantial command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) and counter-C4ISR capabilities. Island-reef-enabled capabilities provide a foundation for a sensor and communications network that covers most of the southern SCS. Radar coverage—whether from outpost-based radar or reconnaissance aircraft orbiting over the island-reefs—extends across an area the size of the eastern United States, from the U.S. east coast to the Mississippi River (Figure 4).

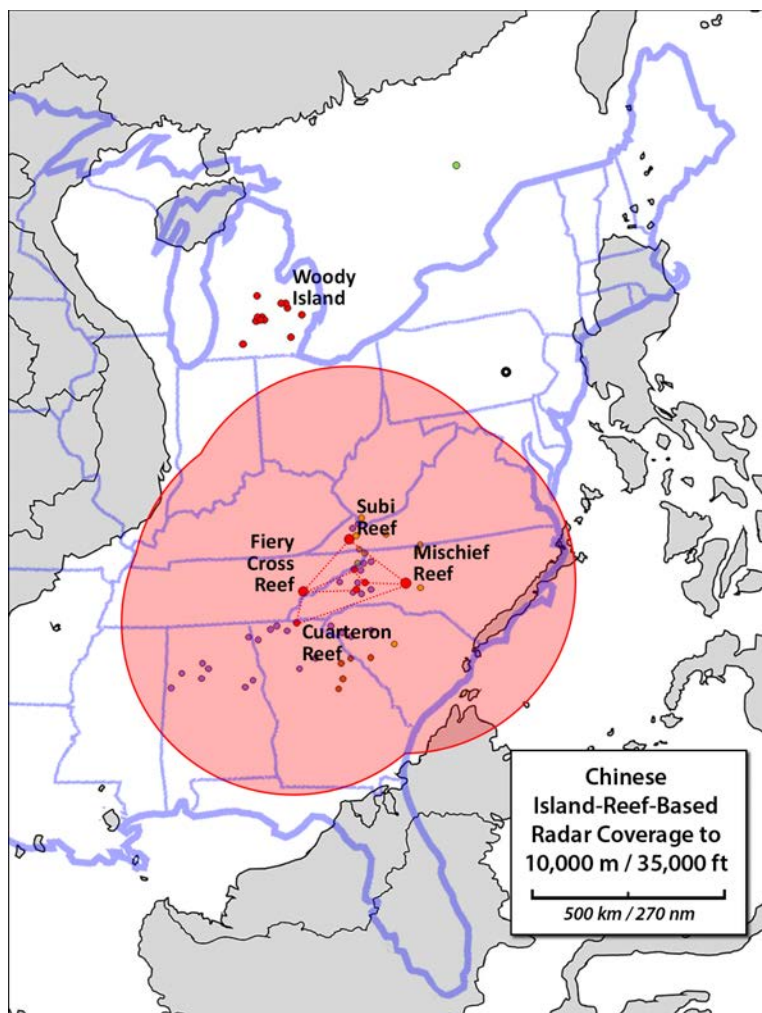


Figure 4. SCS Island-reef Radar Coverage to 35,000 Feet

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The combined information power capabilities on China's SCS outposts, both kinetic and nonkinetic, will work synergistically prior to and throughout military operations to preserve the PLA's access to information in the SCS battlespace while simultaneously denying an adversary access to information. While kinetic, lethal capabilities are integral to PLA operational design, the critical, limiting factor for long-range precision weapons use in the SCS are, in many cases, the C4ISR enabled by the island-reefs.

This survey of the Chinese SCS outposts reveals an emphasis on information power capabilities and the role of these island-reefs as information hard points. Information power capabilities include reliable, secure command, control, communications, and computers (C4); robust, layered intelligence, surveillance, and reconnaissance (ISR); battlespace environmental monitoring; and counter-reconnaissance; as well as significant interference and strike capabilities. These capabilities represent the terrestrial segment of an integrated information system-of-systems (SoS) and reflect the PLA's informationized warfare strategy. Prevailing in SoS confrontation is a fundamental tenant of China's informationized warfare strategy in which the PLA C4ISR SoS must vie for battlespace information control over its adversaries. An example of the concentration of Chinese information power capabilities on Fiery Cross Reef appears in Figure 5.



(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 5. Information Power Capabilities on Northern Fiery Cross Reef

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Persistent ISR allows the PLA to establish a “pattern of life” for the SCS—collecting every detail about the movements of vessels and aircraft, foreign military activity, foreign outpost communications, resupply patterns, weather conditions, and fishing or other commercial activity in the area. From an information perspective, the Chinese outposts give the PLA the same level of knowledge they have about Chinese internal waters, which is, in fact, how Beijing regards the majority of the SCS.

Figure 6 conceptualizes the synergies created by capabilities on the PLA outposts to achieve information superiority. The operational effects generated by China’s SCS outposts are greater than the sum of individual capabilities. The networked kinetic and nonkinetic capabilities generate synergies to preserve PLA access to information while creating compounding effects to deny an adversary access to information.

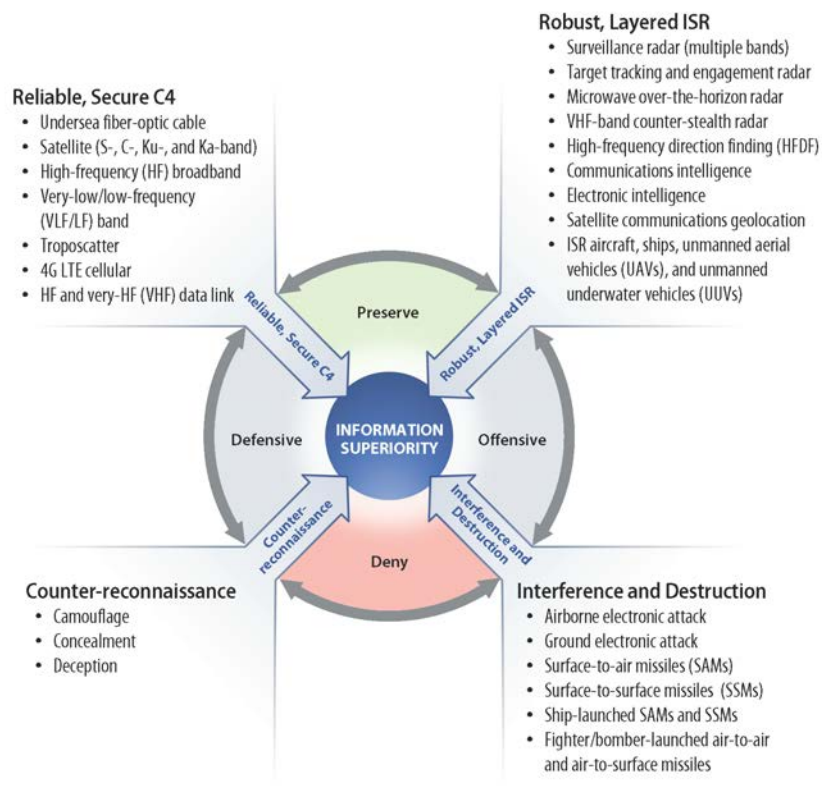


Figure 6. Potential Synergies for Information Power Capabilities Noted on China’s SCS Outposts

Information power capabilities delineated in this MILCAP series include offensive and defensive strike capabilities that may be used to protect the C4ISR capabilities on the island-reefs. They may also be employed in kinetic attacks to create information-related effects in concert with other island-reef capabilities. The primary use of these

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capabilities in an information confrontation does not discount the power projection potential of these strike weapons to attrite adversary forces. Categorizing strike platforms and weapons as information power capabilities simply acknowledges the overarching information-centric strategy in which they will be employed in a conflict.

In the information age, the Chinese believe that success in combat will be realized by winning a struggle for information superiority. China's informationized warfare strategy and information-centric operational concepts are central to how the PLA will generate combat power. The SCS MILCAP series highlights the C4ISR and counter-C4ISR capabilities on the Chinese outposts that may enable those strategies and concepts. Persistent C4ISR and counter-C4ISR capabilities on the Chinese outposts may give the PLA a decided information advantage over any adversaries in the SCS, a design that likely reflects even more pronounced information power capabilities on the Chinese mainland. Kinetic effects will remain an important component of PLA operational design. However, any challenger to Chinese military capabilities in the SCS must first account for and target the very core of the PLA's informationized warfare strategy—its information power.

The SCS MILCAP series is organized around different categories of information power capabilities. Overview graphics of information power capabilities on the major Chinese island-reef outposts—Fiery Cross Reef, Subi Reef, and Mischief Reef—appear in Appendix C (Figure 9 through Figure 11).

South China Sea Military Capability Series Publications

Undersea Fiber-Optic Cable and Satellite Communications

- An undersea fiber-optic cable network complemented by robust, redundant satellite communications is likely the primary communication means for China's SCS outposts.

High-Frequency (HF) Communications

- Large, complex HF antenna arrays are located on each of the major island-reefs, as well as on Cuarteron Reef. A VLF or LF transmitter may also be located on Subi Reef.

Inter-Island Communications

- Inter-island communications include troposcatter, 4G LTE cellular communications, and very-high-frequency (VHF) / ultra-high-frequency (UHF) communications and data link.

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Air and Surface Radar

- Twenty-seven large domes on the Chinese island-reefs house radars that provide air and surface surveillance across the frequency spectrum. Over-the-horizon radar also provide long-range detection of surface targets.

In Depth: Chinese Counter-Stealth Radar

- A unique, circular VHF-band radar array, called synthetic impulse aperture radar (SIAR) is located on Subi Reef. This radar is purported to have significant counter-stealth capabilities.

Electronic Warfare (EW) and Signals Intelligence

- The outposts host a number of fixed electronic intelligence sites and several prepared deployment sites for road-mobile EW or EW-related systems.

Special Mission Aircraft and Unmanned Systems

- ISR and EW aircraft and unmanned systems will likely operate from the island-reefs, increasing responsiveness and extending on-station time in the SCS.

Hardened Infrastructure, Battlespace Environmental Management and Counter-Reconnaissance

- Camouflage, concealment, and deception (CCD) measures include hangars and buildings to conceal aircraft and weapons, as well as underground bunkers for equipment, munitions, fuel and water. Weather stations provide meteorology and hydrology information for military operations.

Offensive and Defensive Strike Capabilities

- The PLA could deploy any road-mobile weapon system or combat aircraft in its inventory to the largest outposts in the SCS. Facilities on the SCS outposts support the deployment of long-range SAMs, anti-ship cruise missiles (ASCMs), and strike-fighter aircraft.

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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 1). 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).³ 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 1. DigitalGlobe Inc. WorldView-3 Satellite Imagery Details

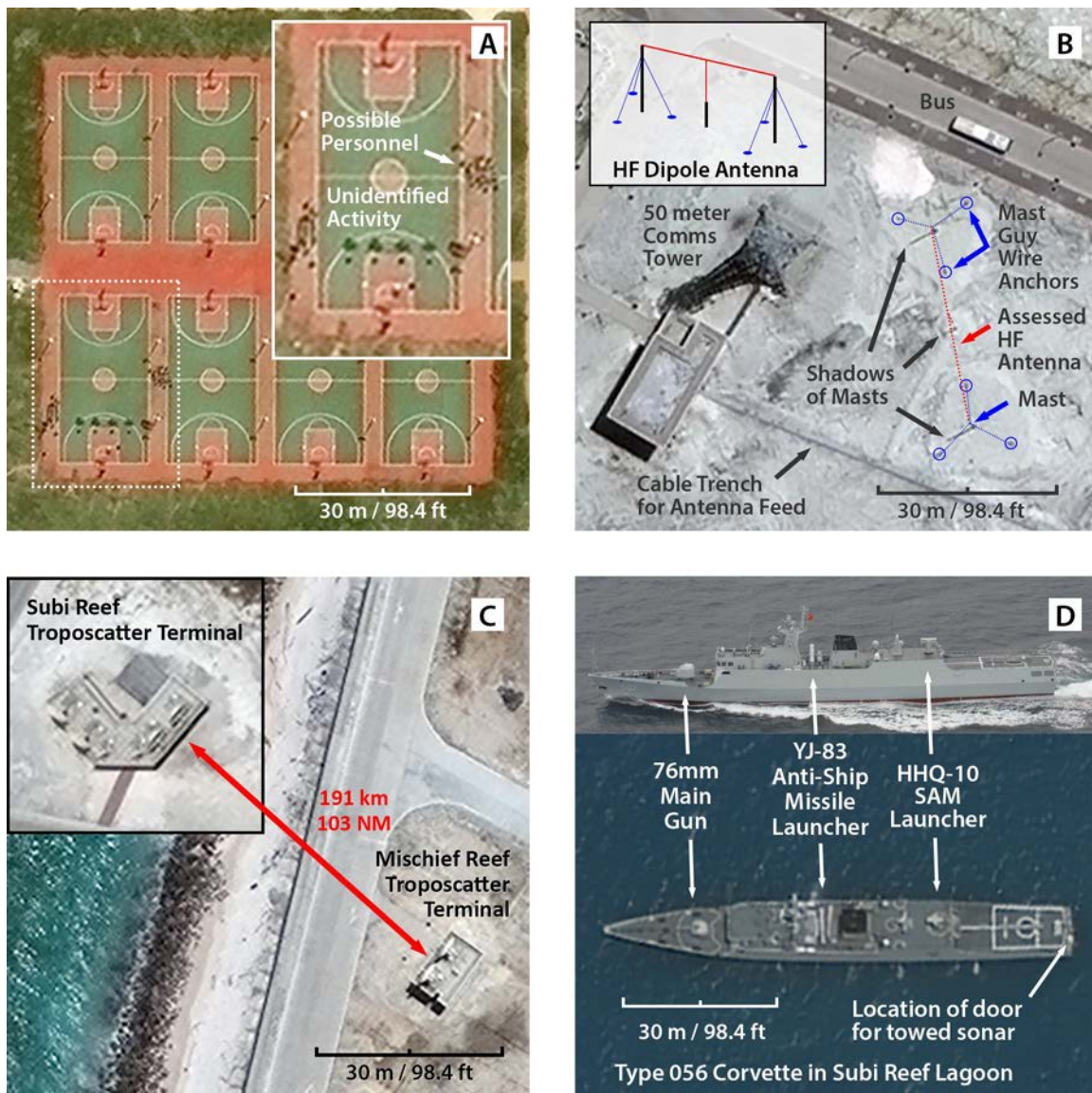
Island-Reef	Location	Date	DigitalGlobe Image ID
Fiery Cross Reef	09°33'00" N, 112°53'25" E	June 14, 2018	104001003C49BB00
Subi Reef	10°55'22" N, 114°05'04" E	June 19, 2018	104001003E841300
Mischief Reef	09°54'10" N, 115°32'13" E	June 19, 2018	104001003D964F00

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 7. The dots made up of only a few pixels in Figure 7(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 7(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 7(C) is an example that indicates the likely connection between two widely separated troposcatter terminals based on antenna pointing angles. Figure 7(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.⁴

³ 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.

⁴ 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.

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

Figure 7. 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.

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Appendix B. South China Sea Maritime Territorial Claims

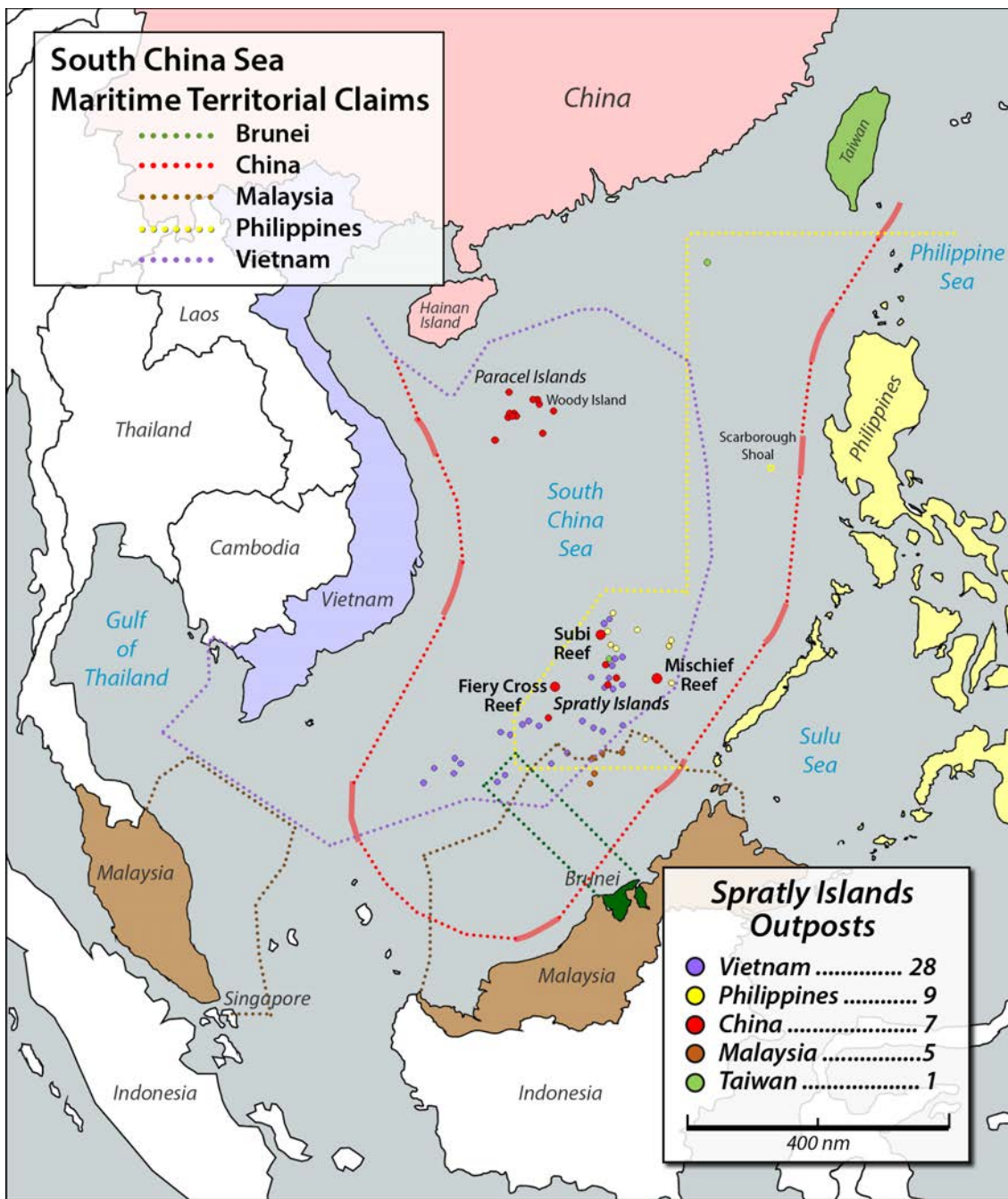
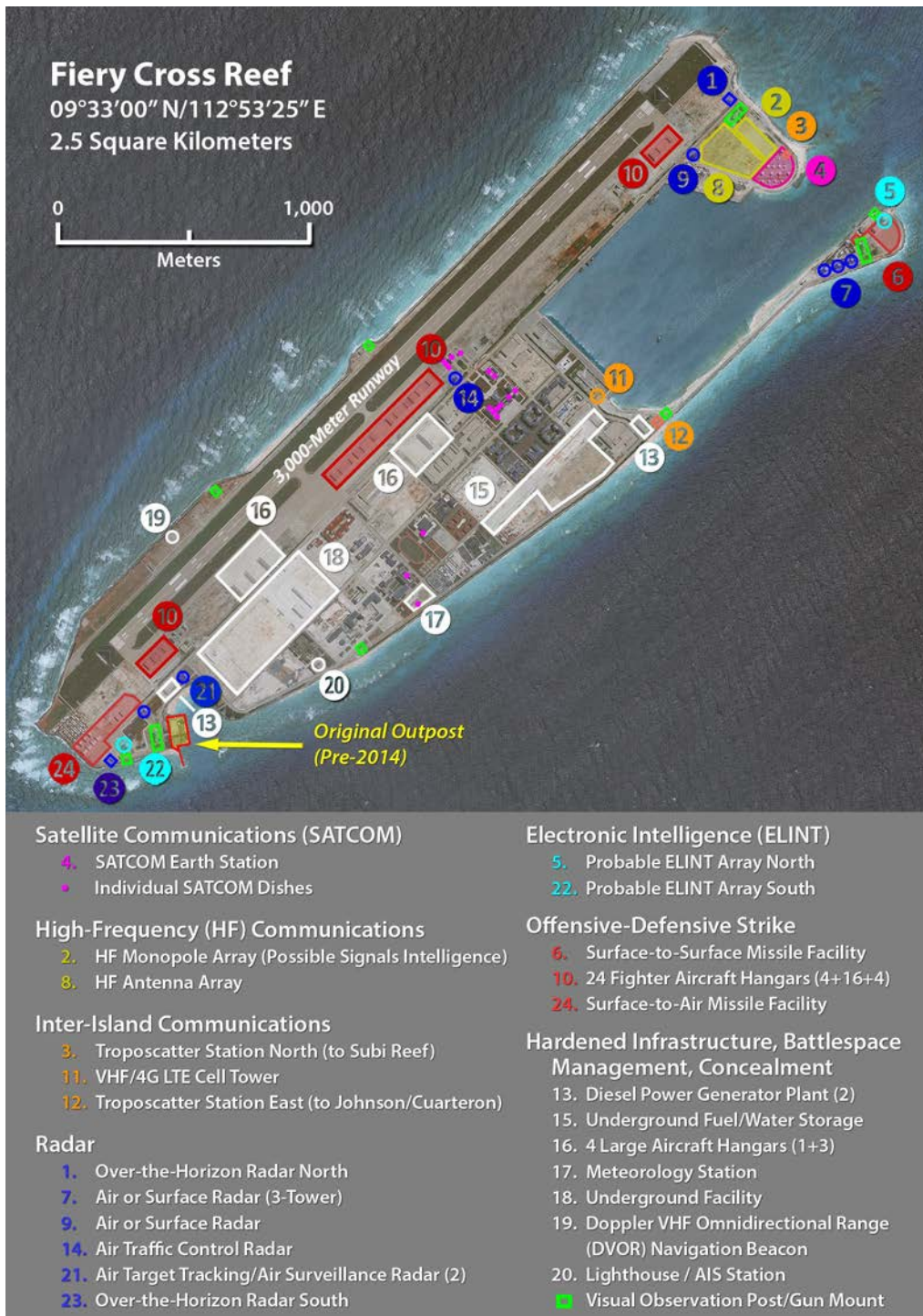


Figure 8. South China Sea Maritime Territorial Claims

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Appendix C. Island-Reef Capabilities Overview Graphics



(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 9. Fiery Cross Reef Overview

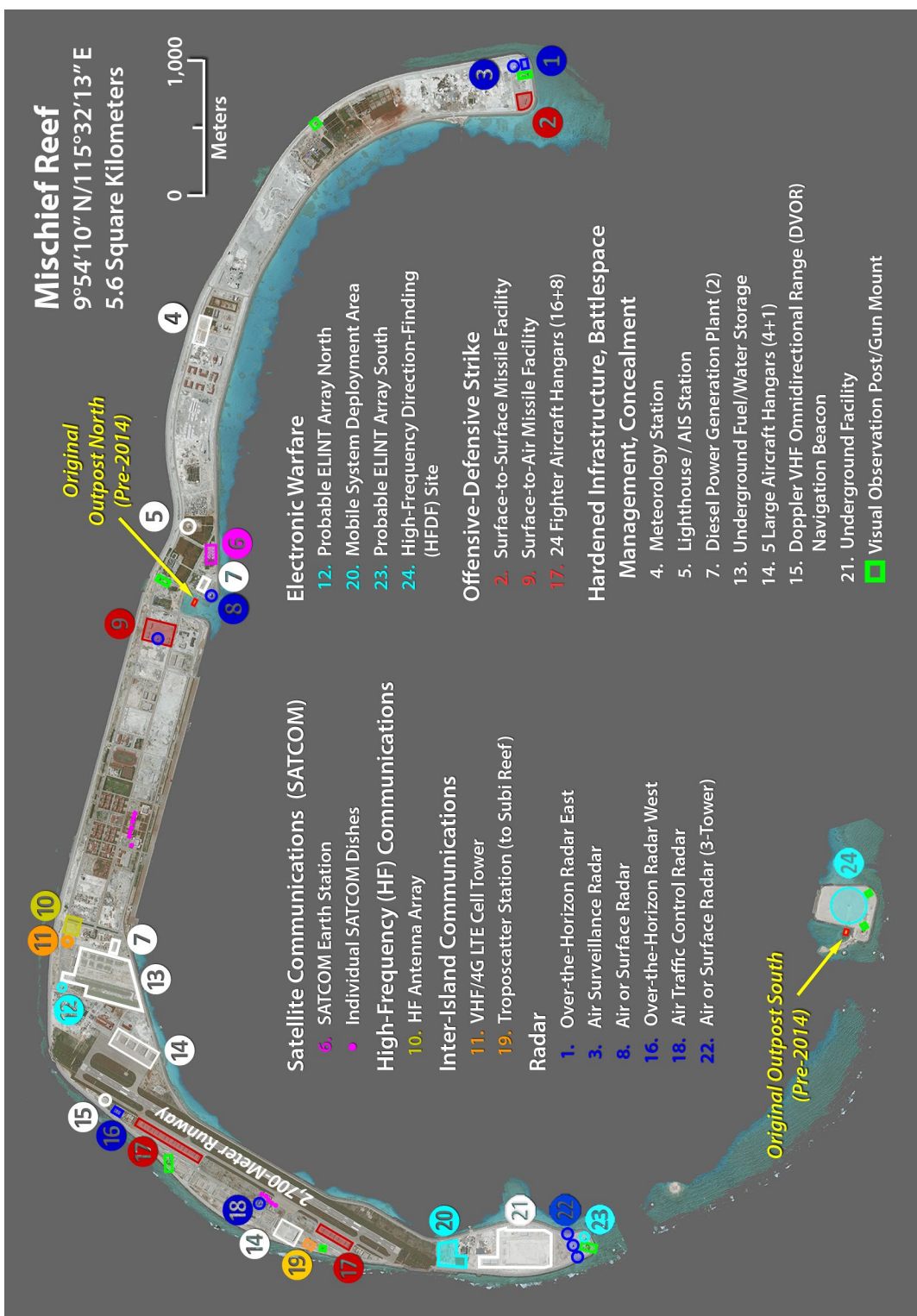
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(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 10. Subi Reef Overview

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(Image © 2020 Maxar/DigitalGlobe, Inc.)

Figure 11. Mischief Reef Overview

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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 2

Table 2. 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
SHF	Super-high frequency	3-30 GHz	S	2-4 GHz
			C	4-8 GHz
			X	8-12 GHz
			Ku	12-18 GHz
			K	18-27 GHz
EHF	Extremely-high frequency	30-300 GHz	Ka	27-40 GHz

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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 operational forces while simultaneously denying adversary operational forces the use of information

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

PLAN—People’s Liberation Army Navy

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 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

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About the Author

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