Able Archers

Taiwan Defense Strategy in an Age of Precision Strike

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PROJECT 2049 INSTITUTE

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Above Image: Chung Shyang UAV at Taiwan's 2007 National Day Parade

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About the Project 2049 Institute

The Project 2049 Institute seeks to guide decision makers toward a more secure Asia by the century's mid-point. Located in Arlington, Virginia, the organization fills a gap in the public policy realm through forward-looking, region-specific research on alternative security and policy solutions. Its interdisciplinary approach draws on rigorous analysis of socioeconomic, governance, military, environmental, technological and political trends, and input from key players in the region, with an eye toward educating the public and informing policy debate.

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EXECUTIVE SUMMARY

The importance of Taiwan, due to its strategic position in the heart of East Asia and in the Western Pacific, far exceeds the size of its territory and population. Moreover, Taiwan is a liberal democracy that plays a positive role in regional security. Yet China's communist party leadership views the Republic of China (ROC, or Taiwan) as an existential political threat. Despite a recent warming in bilateral trade relations, China continues to rely on military coercion to resolve political differences with Taiwan, and the long-term risk of conflict remains high. Going forward, much of Taiwan's continued independence of action will hinge on its air strength.

Contrary to reports, Taiwan has the capacity to deny air superiority to China, and it is likely to maintain this capability well into the future. This is of critical importance because airpower is often the single most decisive element of modern military operations, and it is especially crucial for the defense of island nations like Taiwan. By denying China uncontested control over the air domain, Taiwan can raise the costs of a maritime blockade or amphibious invasion attempt to a prohibitive level. However, the air threat to Taiwan is growing rapidly.

The Chinese People's Liberation Army (PLA) firmly believes that it must suppress Taiwan's air defenses to achieve its strategic objectives. A review of internal Chinese military documents and technical studies reveals that the PLA would attempt surprise attacks to neutralize Taiwan's air force at the outset of conflict. A large-scale effort is underway in China to build ballistic missiles and other weapons capabilities for complicating airbase operations in Taiwan. The implications of this armament program are serious, not only for Taiwan, but also for the United States and other regional air powers.

To counter this emerging challenge, Taiwan, assisted by the United States, is constructing what may be the world's most robust air and missile defense network. This includes significant investments into early-warning radars, other intelligence, surveillance, and reconnaissance (ISR) assets, fighter upgrades, missile defense systems, and airbase hardening and resiliency. Taiwan's objective is to maintain air parity with China, not in terms of quantity, but through superior quality.

Taiwan is developing unmanned aerial vehicles (UAVs) and strike systems able to effect single points of failure in the PLA's theater-level operational system. These capabilities may offset Taiwan's geographic vulnerabilities, numerical, and other asymmetric disadvantages. In addition, Taiwan plans to acquire next generation stealth fighters with short take-off and landing capabilities, and submarines that can conduct anti-surface, anti-submarine, and ISR operations. But more can be done to communicate to the PLA that the costs of potential cross-Strait aggression would far outweigh any hoped for benefits.

Taiwan is leveraging its current advantages to undercut the coercive value of the PLA's growing arsenal of increasingly accurate ballistic missiles. Beyond hard military issues, the United States has a significant role to play. Among a range of possible initiatives, Washington should grant consideration to: (1) increasing senior military officer visits to Taiwan, up to and beyond two star rank, with significant joint experience; (2) promoting working groups for strategic and operational innovation, technical assistance, and defense industrial cooperation; and (3) incorporating Taiwan into the rebalance to Asia, and U.S. strategy in the Asia-Pacific Region.

The U.S. and ROC governments, working as partners with other allies who share common interests, can successfully balance against the inherent risks and dangers surrounding China's emergence as a regional military power. However, as this study suggests, the PLA is rapidly advancing its precision strike capabilities, and much hard work will have to be done to stay ahead of it.

INTRODUCTION

The People's Republic of China (PRC) is engaged in an ambitious military modernization program that has the potential to rapidly erode the defensive positions of the United States, Taiwan, Japan, and others in the Western Pacific. Among the strategic drivers of the PRC's military build-up, the most prominent is attaining the ability to apply overwhelming force against the Republic of China (ROC, or Taiwan), and in a manner that could complicate foreign intervention. Along these lines, precision strike capabilities such as ballistic and cruise missiles, along with armed drones and guided rockets, are important strategic enablers. The Chinese People's Liberation Army (PLA) views the development of these weapon systems as decisive for future air operations against Taiwan. Given the centrality of airpower for modern warfare, Chinese writings indicate a belief that the PLA must first control the skies above the Taiwan Strait before it can operate on the surface below.

To achieve its strategic objectives, the PLA is striving for the ability to suppress Taiwan's air defenses where they are at their weakest–on the ground. The PRC military armament program is closely associated with a number of maturing precision strike capabilities designed for attacking airbases. Referred to as "airfield runway blockades" by the PLA, such operations intend to overcome Taiwan's air defenses through the use of missiles armed with penetrating warheads. The PLA hopes that once runway surfaces have been sufficiently cratered, Taiwan's highly capable air force pilots will be unable to take-off and wage war in the air. At that point, the PLA plans to take control of the skies over Taiwan and execute follow-on bombing operations at significantly reduced cost and risk.

Maintaining the ability to deter and if necessary defeat any PLA attempt to establish air superiority over its sovereign territory is vital to Taiwan's continued existence as a self-governing democratic state. By credibly threatening to deny the PLA access to its airspace, the ROC can alter the PRC's strategic calculus. The PLA is unlikely to mount a maritime blockade or amphibious invasion against Taiwan unless it can first achieve control over the air domain. Taipei's ability to stop the PLA from gaining air superiority reduces the possibility that Beijing may be tempted to resort to the use of force in a future crisis. Moreover, by maintaining a strategy that includes asymmetric and innovative defenses for slowing the PLA's operational timelines, the ROC military can provide U.S. government leaders with time to mobilize political, military, and economic support during a crisis or conflict.

While air superiority alone does not ensure success in deterring war or winning a military campaign, it is often decisive in military operations. Furthermore, cross-Strait crisis stability depends on eliminating any PRC incentives for "preemptive" first strikes. Improved air and missile defense is crucial to undermining potential PRC aggression. As Taiwan evaluates future force postures during a period of fiscal austerity and uncertainty over U.S. security commitments, the Chinese defense establishment is making significant advances in developing a force capable of dominating the air environment around its periphery. In light of these trends, what is the PRC's strategic thinking on Taiwan airbase vulnerability and how well positioned is it to exploit perceived weaknesses? What steps has Taiwan taken to improve its capacity to withstand surprise attack, recover, and generate sufficient combat power to achieve defense objectives in the face of continued enemy action? What more can be done?

This paper provides an overview of the evolving airpower threat confronting Taiwan, and, by extension, the United States. This paper will begin by evaluating the PRC's growing capacity for conducting precision strike operations against the ROC. Next, it will explore Chinese military-technical writings to better understand the PLA's plans and capabilities for attacking Taiwan. Then it will assess Taiwan's military modernization program, and, in particular, its efforts to deny the PLA air superiority. This paper will conclude with a brief discussion on Taiwan's future defense strategy and offer recommendations for policymakers to consider as they work to maintain regional peace and stability.

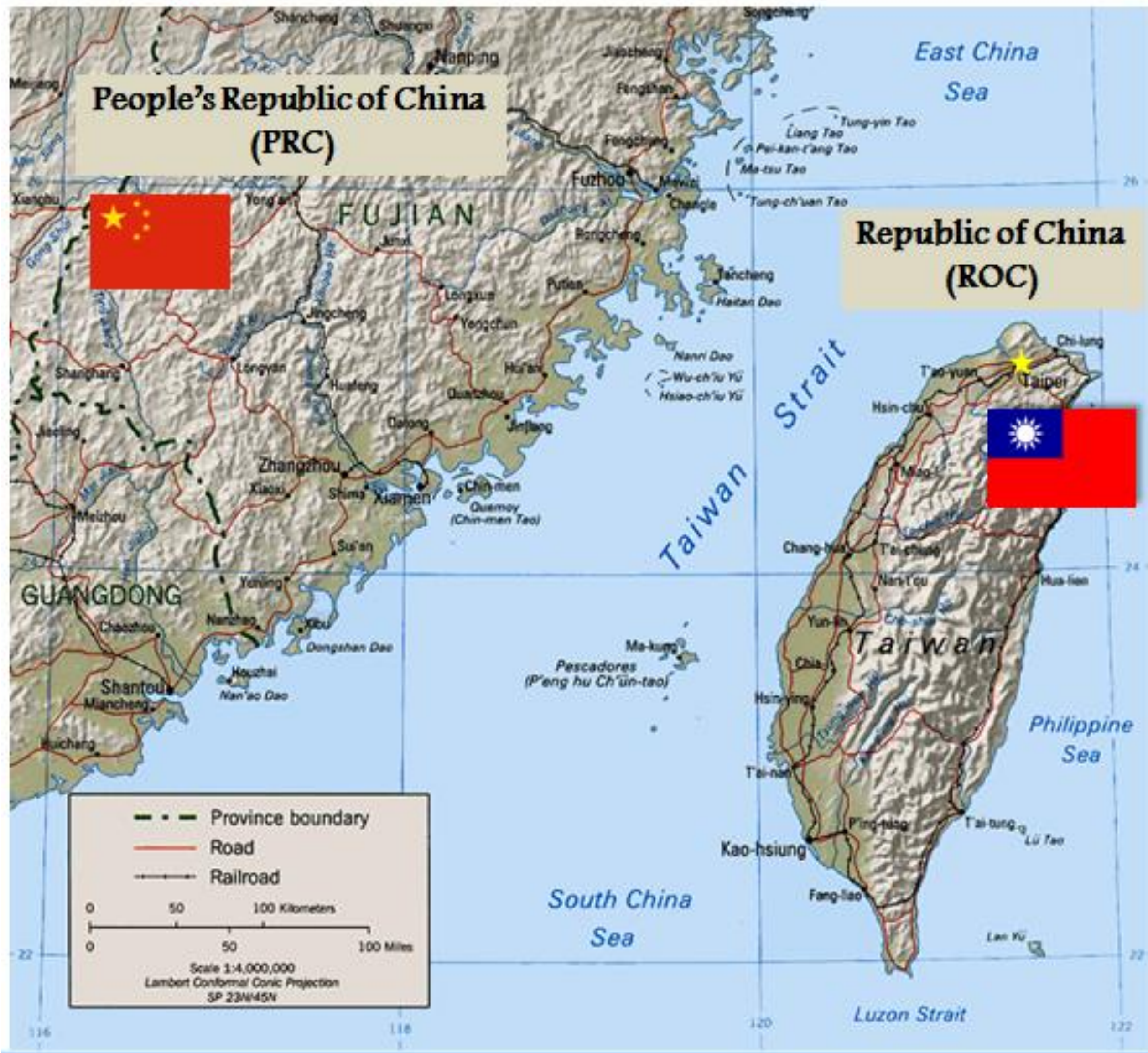

Figure 1: Map of Taiwan Strait Area (Source: Wikimedia and the Project 2049 Institute).

CHINESE PRECISION STRIKE

Driven by its long-standing mission to prepare for a conflict involving Taiwan, and limited by a relatively backward air force, the PLA has been investing heavily in conventionally armed ballistic missiles as a means of acquiring an advantage across the Taiwan Strait. First deployed in the early 1990s, the PLA's ballistic missiles lacked the ability to reliably target military facilities on Taiwan, and instead were leveraged for their coercive effects as weapons of terror during the Third Taiwan Strait Crisis of 1995-1996. Technological advancements over the past decade, however, have allowed the PLA's Second Artillery Force to greatly improve the tactical utility of its conventional ballistic missiles.

Today the Second Artillery is able to hold almost all ROC military bases at risk with its short-range ballistic missile (SRBM) force. The Second Artillery is also increasingly capable of using its medium-range ballistic missile (MRBM) force to threaten front-line U.S. airbases in Japan and carrier groups in the Western Pacific. This situation undermines confidence in American commitments to aid in the defense of Taiwan should conflict occur. Moreover, the Second Artillery is developing a conventional intermediate-range ballistic missile (IRBM) for striking U.S. airbases on Guam and the Northern Mariana Islands that would be critical in responding to Chinese aggression against Taiwan.[1]

Ballistic Missiles. The Second Artillery has deployed a large force of road-mobile SRBMs opposite Taiwan, and is continuing to improve its missiles in terms of both quantity and quality. The National Air and Space Intelligence Center (NASIC) released an authoritative report in 2013 that stated the PLA has deployed six SRBM types, including the newly developed DONG FENG-16 (DF-16, or CSS-11).[2] The PLA is also developing two new SRBMs along with maneuvering reentry vehicles and other capabilities for greater penetration of targets in Taiwan. The Second Artillery was reported to have fielded over 1,100 SRBMs across from Taiwan by late 2012, and it continues to deploy more advanced variants while replacing earlier generation missiles that lack precision strike capabilities.[3] Looking ahead, one recent report projected the PLA could have approximately 1,400 SRBMs targeting Taiwan by 2025. According to the report, these would be primarily comprised of advanced DF-11 (CSS-7), DF-15 (CSS-

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[1] Ballistic missile types are defined as follows: SRBMs have a range of under 1,000 kilometers (or 621 miles); MRBMs have ranges from 1,000 to 3,000 kilometers or (621 to 1,864 miles); and IRBMs have ranges from 3,000 to 5,500 kilometers or (1,864 to 3,418 miles). Any ballistic missile with a range of over 5,500 kilometers (3,418 miles) is defined as an intercontinental ballistic missile (ICBM). See *Ballistic and Cruise Missile Threat* (Wright-Patterson AFB, OH: National Air and Space Intelligence Center, July 2013), p. 9, accessible online at http://www.afisr.af.mil/news/story.asp?id=123355694.
[2] Ibid., pp. 10-12.
[3] *Military and Security Developments Involving the People's Republic of China 2013* (Arlington, VA: Department of Defense, 2013), p. 42, accessible online at http://www.defense.gov/pubs/2013_china_report_final.pdf.

6), and DF-16 (CSS-11) SRBM variants, and include special warheads for targeting Taiwan's current ballistic missile defenses.[4]

The Second Artillery's SRBM infrastructure across from Taiwan is commanded by the 52 Base, headquartered in Anhui Province's Huangshan City.[5] The 52 Base oversees at least six SRBM brigades, and as many as three MRBM brigades in southeastern China. Two other brigades that could be involved in a Taiwan scenario appear to report directly to the 53 Base in Kunming. The Second Artillery's SRBM brigades each have a command post that oversees six launch battalions, a technical support battalion, a communications battalion, an electronic countermeasures (ECM) group, and a rail transfer point. A dedicated regiment under the 52 Base headquarters appears to store most SRBMs and their related assemblies and components at a hardened facility in Shangrao County, Fujian Province, with annexes around Qimen and Leping.

Second Artillery SRBM brigades arrayed against Taiwan have been identified as follows:

- Leping/Shangrao SRBM Brigade (96165 Unit). Located in Jiangxi Province, this unit is believed to be armed with DF-15 or possible DF-16 SRBM variants.
- Yong'an SRBM Brigade (96167 Unit). Located in Fujian, this unit is believed to be armed with DF-15 SRBM variants.
- Meizhou SRBM Brigade (96169 Unit). Located in Guangdong, this unit is believed to be armed with DF-11 SRBM variants.
- Ganzhou SRBM Brigade (96162 Unit). Located in Jiangxi, this unit is believed to be armed with DF-11 SRBM variants.
- Jinhua SRBM Brigade (96164 Unit). Located in Zhejiang, this unit is believed to be armed with DF-11 SRBM variants.
- Xianyou SRBM Brigade (96180 Unit - formerly under Nanjing Military Region). Located in Fujian Province, this unit was previously equipped with DF-11 SRBMs. Its current missile system is unknown.
- Puning SRBM Brigade (96212 Unit - formerly under Guangzhou Military Region). Located in Guangdong Province, this unit was previously equipped with DF-11 SRBMs. Its current missile system is unknown.[6]

While the SRBM launch battalions under each of the above SRBM brigades are equipped with road mobile missiles, identified launch units are generally located within

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[4] Defense Policy Advisory Committee, *China's Military Threats against Taiwan in 2025* (Taipei, Taiwan: New Frontier Foundation, March 2014), p. 73, accessible online at http://www.dpp.org.tw/upload/news/20140304120411_link.pdf.

[5] The following section draws from Mark Stokes, "Expansion of China's Ballistic Missile Infrastructure Opposite Taiwan," *AsiaEye Blog*, April 18, 2011, at http://blog.project2049.net/2011/04/expansion-of-chinas-ballistic-missile.html. See also Mark A. Stokes and Ian Easton, *Evolving Aerospace Trends in the Asia-Pacific Region: Implications for Stability in the Taiwan Strait and Beyond* (Arlington, VA: Project 2049 Institute, May 2010), pp. 9-10.

[6] There are also two new ballistic missile brigades that have been identified by Mark Stokes in Shaoguan and Qingyuan, respectively. The former is armed with a new type of missile that has not yet been identified. The latter is believed to be armed with medium-range DF-21D ASBMs. See Mark Stokes, "Expansion of China's Ballistic Missile Infrastructure Opposite Taiwan," *AsiaEye Blog*, April 18, 2011, at http://blog.project2049.net/2011/04/expansion-of-chinas-ballistic-missile.html.

100 kilometers or less of their respective brigade command posts and rely heavily upon railway lines for transport.[7] In a conflict, it can be expected that they would deploy to a limited number of pre-surveyed launch sites.[8] The Second Artillery's training exercises frequently emphasize maneuver, camouflage, and other measures for decreasing the vulnerability of launch units.[9] Each SRBM launcher has around seven to eight missiles assigned to it, and each time Second Artillery units launch a missile they move to another location before firing again to enhance survivability.[10]

Authoritative PLA documents, such as the *Science of Military Strategy* and the *Second Artillery Force Science of Campaigns*, indicate that the principal mission of China's SRBMs would be to strike Taiwan's air defenses at the outset of a conflict.[11] Such operations would include SRBM attacks on Taiwan's air defense command and control centers, early-warning radars, and airbases. Only once Taiwan's air defense networks were sufficiently degraded would the PLA commit its manned air combat forces to otherwise perilous bombing operations against Taiwan's broader defense infrastructure and seek to establish air superiority.[12] PLA writings suggest that surprise attacks with SRBMs at the outset of conflict would be conducted in coordination with land attack cruise missiles and unmanned aerial vehicles (UAVs).[13]

Cruise Missiles and UAVs. To augment its ballistic missile forces, the PLA has recently begun investing in large numbers of land attack cruise missiles (LACMs) and armed UAVs to saturate Taiwan's air and missile defense systems. At both the operational and strategic levels of warfare, China's cruise missiles and drones have serious implications for Taiwan's security. Like the Second Artillery's ballistic missile systems, LACMs and UAVs are technologically challenging to defend against. However, unlike ballistic missiles which generally have fixed, predictable trajectories, cruise missiles and drones are able to strike from any direction and fly at very low altitudes, making them difficult to detect and counter. Cruise missiles and UAVs are also more accurate and inexpensive to build than ballistic missiles and, because of their relatively small sizes, can be launched from a variety of platforms, further adding to their operational agility.[14] The Second Artillery appears to operate two brigades equipped

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[7] See Stokes and Easton, p. 11.
[8] Theoretically, road mobile launch units could use an unlimited number of ad hoc sites for conducting operations. However, given the organizational culture of the PLA, with its strong emphasis on the strict adherence to pre-arranged plans, it can be expected that Second Artillery launch units would generally operate from prepared sites.
[9] *Military and Security Developments Involving the People's Republic of China 2013*, p. 31.
[10] The author is indebted to Ken Allen for this point.
[11] See Peng Guangqian and Yao Youzhi (eds.), *The Science of Military Strategy* (Beijing: Military Science Publishing House, 2005), p. 327; and Yu Jixun, ed., *Second Artillery Force Science of Campaigns* [*第二炮兵战役学*] (Beijing: Liberation Army Press: 2004), pp. 392-398.
[12] Yu Jixun, et al., pp. 392-398.
[13] Yu Jixun, p. 398.
[14] For a detailed overview of cruise missile capabilities and developments, see Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions* (Washington, D.C.: NDU Press, 2014). See also Dennis M. Gormley, *Missile Contagion: Cruise Missile Proliferation and the Threat to International Security* (Westport, CT: Praeger Security International, 2008); and Ian Easton, *The Assassin Under the Radar: China's DH-10 Cruise Missile*

with CJ/DH-10 ground-launched cruise missiles (GLCMs). Subordinate to the 53 Base and the 55 Base, respectively, these GLCM brigades are organized along similar lines as their SRBM counterparts, with six launch battalions consisting of two companies each.[15] Identified as rapid reaction units capable of cross-country deployment, these GLCM brigades are capable of holding targets in Taiwan at risk from a distance of at least 1,500 kilometers.[16] While unconfirmed, a tentative assessment suggests that they may be deployed as follows:

- Liuzhou GLCM Brigade (96215 Unit). Located in Guangxi Province; subordinate to the 53 Base.
- Yichun GLCM Brigade (96317 Unit). Located in Jiangxi Province, subordinate to the 55 Base.[17]

In addition, the Second Artillery appears to operate a number of UAV units that would support precision strike operations in a Taiwan contingency. Second Artillery UAVs could provide direct targeting support for conventional ballistic and land attack cruise missile operations. They could also engage in mass "kamikaze" attacks on radars and other important air defense sites. Second Artillery analysts view UAVs as critical enablers for cueing, target acquisition, and battle damage assessment (BDA) missions in support of ballistic and cruise missile operations.[18] While speculative, possible units under direct command of the Second Artillery Headquarters in Beijing include:

- The 96605 Unit at Hui'an Air Base in Fujian Province; and
- The 96626 Unit in Dongyang City, Zhejiang Province.

These units may be tasked with providing national-level intelligence to support strategic strike operations against Taiwan. SRBM units that may be equipped with tactical UAVs include:

- The 52 Base's 96180 Unit in Xianyou, Fujian Province (SRBM brigade formerly under Nanjing Military Region); and
- The 53 Base's 96212 Unit in Puning, Guangdong Province (SRBM brigade formerly under Guangzhou Military Region).[19]

Program (Arlington, VA: Project 2049 Institute, October 2009), p. 4, at http://project2049.net/documents/assassin_under_radar_china_cruise_missile.pdf.

[15] It should be noted that the commander of a GLCM company is likely to be a captain or first Lieutenant without much experience. While unknown, it seems unlikely that they would have the authority to launch "their" missiles. The author is indebted to Ken Allen for this point.

[16] Stokes and Easton, pp. 14-15.

[17] Ibid.

[18] Ian M. Easton and L.C. Russell Hsiao, *The Chinese People's Liberation Army's Unmanned Aerial Vehicle Project: Organizational Capacities and Operational Capabilities* (Arlington, VA: Project 2049 Institute, March 2013), pp. 11-12, accessible online at http://project2049.net/documents/uav_easton_hsiao.pdf. Unless otherwise noted, the following section on UAVs draws from this report.

[19] Mark Stokes, "Expansion of China's Ballistic Missile Infrastructure Opposite Taiwan," *AsiaEye Blog*, April 18, 2011, at http://blog.project2049.net/2011/04/expansion-of-chinas-ballistic-missile.html.

Aside from Second Artillery units, the PLA Air Force (PLAAF) appears to have an unmanned combat aerial vehicle (UCAV) brigade in the Nanjing Military Region Air Force Headquarters in Fuzhou, with five subordinate groups in Fujian and Guangdong. At least two groups could be equipped with converted J-6 UCAVs. With up to 200 aircraft believed to be in service, the PLAAF's J-6 UCAVs are likely intended for use as decoys to saturate and destroy Taiwan's air defense systems and help create gaps for Second Artillery missiles to exploit. These UCAVS could also be tasked with a variety of "high-risk" bombing and electronic warfare missions. The PLAAF has imported approximately 100 HARPY drones from Israel for targeting Taiwan's air defense radars with small anti-radiation (radar seeking) warheads.

Looking ahead, it appears that PLAAF may be developing UAVs that can fly in formations, engage in aerial refueling, and take-off and land autonomously. PLAAF engineers have already begun to explore using manned aircraft to control multiple UCAVs. For example, one well-funded study in 2011 simulated the use of one manned fighter aircraft to control three or more UCAVs for a land attack mission.[20] This appears to be linked to a PLAAF ambition of developing UAVs for long-range bombing missions.[21]

The PLA ground forces across Taiwan are equipped with tactical reconnaissance UAVs. Candidate platforms include the heavier BZK-005 and BZK-009; the medium weight ASN-105 and ASN-206; and the light ASN-104 and W-50.[22] Elite amphibious divisions under the Taiwan-focused 1st Group Army and 42nd Group Army appear to be the first in China to establish reconnaissance battalions with UAV-equipped companies.[23] PLA ground force artillery units have been investing in UAVs for battlefield reconnaissance missions. PLA writings describe reconnaissance UAVs as particularly well suited for supporting over the horizon artillery and long-range rocket units.[24]

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[20] Liu Yuefeng and Zhang An, "Research on Multi-Agent Architecture for Coordinated Formation Air-to-Ground Attacks [编队协同对地攻击多 Agent 系统体系结构研究]," *Xitong Fangzhen Xuebao* (Journal of System Simulation), February 2011, pp. 372-375. Note that this research was funded in part by the PRC's Aviation Science Grant [航空科学基金].

[21] Easton and Hsiao, p. 12.

[22] *The Military Balance 2013* (London, UK: Institute for International and Strategic Studies, March 2013), p. 288-289.

[23] These are reportedly the Guangzhou MR's 42nd Group Army's 124th Amphibious Division, and the Nanjing MR's 1st Group Army's 1st Amphibious Division. See "Merrily Discussing China's Amphibious Mechanized Divisions Revealed in Army Newspaper [笑谈军报透露的中国两栖机械化师]," *China Military*, January 5, 2005, at http://military.china.com/zh_cn/critical3/27/20050105/12049492.html. See also "Taiwan Media Says Guangzhou MR Has Established Amphibious Mechanized Division for Pincer Attacks from North and South [广州军区设两栖机械化师 台媒体：南北夹击]," *Anhui News*, January 10, 2005, at http://mil.anhuinews.com/system/2005/01/10/001099717.shtml.

[24] Easton and Hsiao, p. 13.

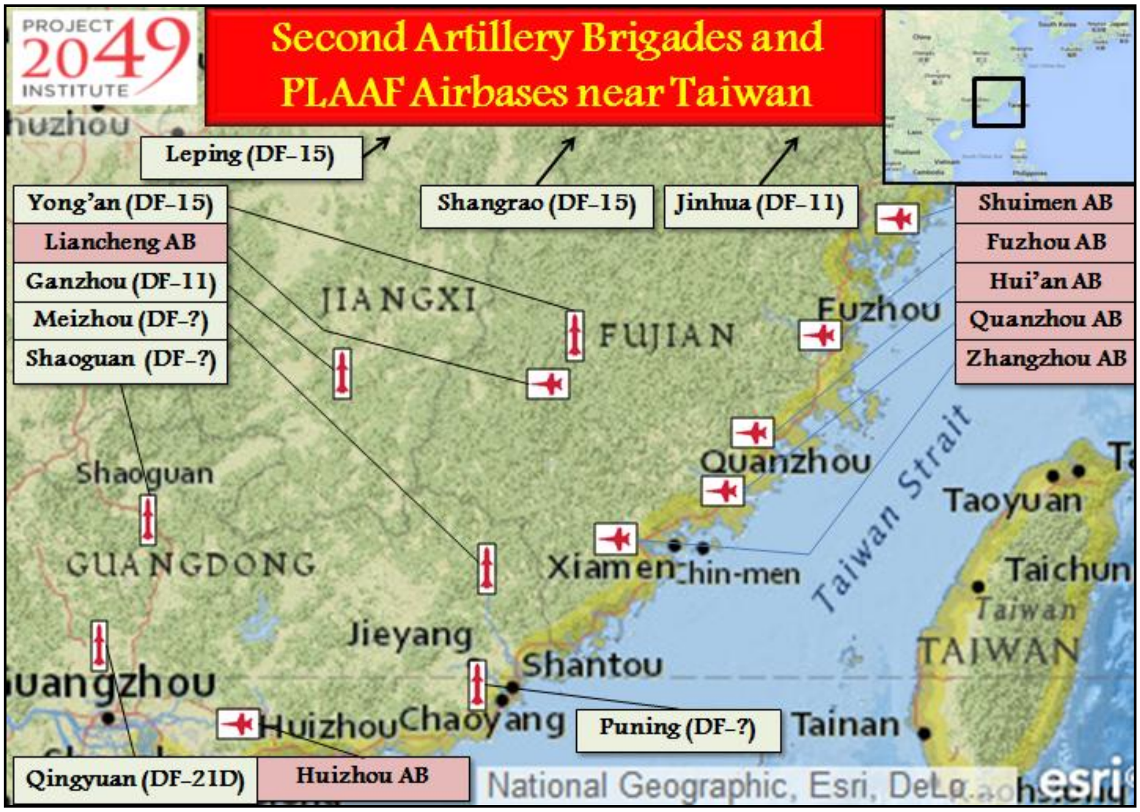

Figure 2: Second Artillery Brigades and Select PLAAF Airbases near Taiwan.

Rockets and Aircraft. According to reports, the PLA is developing the PHL-300 and the AR-3 multiple rocket launchers (MRLs) for delivering precision munitions capable of striking targets within or even across the Taiwan Strait.[25] Receiving units are likely based in Quanzhou, under the 31st Group Army's 3rd Artillery Brigade, and Wuxi, under the 1st Group Army's 9th Artillery Division.[26] During a conflict, it could be expected that the PLA would task its MRL units with strikes on key Taiwan-controlled islands along the Fujian coastline, including Kinmen, Matsu, Tung-yin, and Wu Chiu-yu. Longer-range variants could be tasked with strikes on Taiwan's strategically located Penghu Islands, and perhaps even the areas along the west coast of Taiwan.[27]

In terms of manned aircraft, the number of PLAAF fighters and bombers deployed across from Taiwan has held steady in recent years. However, the overall force is the world's third-largest, and it is growing steadily. PLAAF currently has 600 modern combat aircraft (including fighters, bombers, and attack aircraft), and an additional

[25] *Military and Security Developments Involving the People's Republic of China 2013* (Arlington, VA: Department of Defense, 2013), p. 42, accessible online at http://www.defense.gov/pubs/2013_china_report_final.pdf.

[26] For an excellent overview of PLA units in the Nanjing MR, see Dennis J. Blasko, *The Chinese Army Today* (New York: Routledge, 2012), p. 96-98.

[27] For a detailed Taiwanese report on China's MRL types and capabilities, see Ying Tianxing, "Threat to Taiwan or Export Only: China's Armament Dynamics Regarding Multiple Tube Rockets and Artillery Missiles [對台威脅或專為出口? 中國軍備動態多管火箭與砲兵飛彈]," *Defence International*, February 2009, pp. 80-87.

1,300 antiquated combat aircraft.[28] The PRC has modernized some of its older H-6 bombers by integrating new stand-off weapons. For example, the H-6K variant is thought to be able to carry six LACMs for long-distance precision strikes.[29] PLAAF's air-launched LACM inventory includes the YJ-83, the KD-88, the CJ-20, and the CM-802AKG, some of which are still in development.[30] PLAAF also fields a small number of air-to-surface missiles as well as precision-guided munitions, such as laser-guided bombs, and all-weather satellite-guided bombs.[31]

PLAAF appears to be making qualitative improvements to its force in the Nanjing MR. For example, some H-6 bombers have been converted into aerial refueling aircraft,[32] and at least one J-10 fighter regiment near Taiwan is receiving increased air combat training and has qualified 90 percent of its pilots in aerial refueling.[33] PLAAF is also beginning to deploy improved aircraft command and control (C2), electronic warfare, and data links.[34] In addition, PLAAF has introduced two stealth prototypes, referred to as the J-20 and the J-31 fighters, although the quality of their stealth features, avionics, sensors, and engines are all questionable.[35]

The PLA has an extensive network of more than 50 military, civil, and reserve airfields across Taiwan that it can use to support large-scale operations in a contingency. Of these, however, only a limited number are capable of high-intensity operations because of a dearth in quality pilots and skilled ground crews. PLAAF training is improving, but its joint, tactical air-to-air and air-to-ground strike training continues to lag well behind Taiwan standards. Anything beyond well rehearsed, pre-planned strikes would be severely challenging for PLAAF, and its efficiency is expected to decline during dynamic and rapidly changing battlespace conditions that would define an air war with Taiwan. PLAAF's principal strength remains air defense, and it is particularly well prepared for this core mission along the Taiwan Strait.[36]

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[28] *Military and Security Developments Involving the People's Republic of China 2013* (Arlington, VA: Department of Defense, 2013), p. 9.
[29] Ibid.
[30] Ibid., p. 40.
[31] Ibid. p.40.
[32] Ibid., p. 9.
[33] See "The Military Report [军事报道]," *CCTV-7*, April 15, 2014, at http://military.cntv.cn/2014/04/15/VIDE1397567340182982.shtml.
[34] *Military and Security Developments Involving the People's Republic of China 2013* (Arlington, VA: Department of Defense, 2013), p. 9.
[35] See Wendell Minnick, "Experts: China Still Lags West in Advanced Aircraft Technologies," *Defense News*, August 3, 2014, at http://www.defensenews.com/article/20140803/DEFREG03/308030011/Experts-China-Still-Lags-West-Advanced-Aircraft-Technologies; Gabe Collins and Andrew Erickson, "China's New Project 718/J-20 Fighter: Development outlook and strategic implications," *China Sign Post*, No. 18, January 17, 2011, at http://www.andrewerickson.com/2011/01/j-20-fighter-development-outlook-strategic-implications/; and Kyle Mizokami, "The Chinese Military is a paper dragon," *Real Clear Defense*, September 5, 2014, at http://www.realcleardefense.com/articles/2014/09/05/the_chinese_military_is_a_paper_dragon_107416-8.html.
[36] The above paragraph draws from Lee Fuell, "Department of the Air Force Presentation to the U.S.-China Economic and Security Review Commission," *USCC*, January 30, 2014, available online at http://www.uscc.gov/sites/default/files/Lee%20Fuell_Testimony1.30.14.pdf.

Table 1. PLA Air and Missile Threat to Taiwan

Weapon	*Type*	*Range (km)*	*Number Deployed near Taiwan*	*Details [Service]*
Ballistic Missiles	DF-11 (CSS-7)	300-600	700-750 missiles and 120-140 launchers (2010 estimate)	SRBM [Second Artillery Force, SAF]
	DF-15 (CSS-6)	600-850	350-400 missiles and 90-110 launchers (2010 estimate)	SRBM [SAF]
	DF-16 (CSS-11)	800+	Unknown	SRBM [SAF]
	CSS-8	150	Unknown	SRBM
	CSS-9	150-260	Unknown	SRBM
	CSS-14	150-280	Unknown	SRBM
	CSS-X-16	200	In development	SRBM
	CSS-X-15	280	In development	SRBM
Cruise Missiles	CJ-10	1,500- 2,000	Unknown, 200-500 total missiles on 45-55 launchers (2010 estimate)	GLCM with four warhead variants; deployed on tri-canister launcher [SAF]
	CJ-20	Unknown	In development	LACM to be launched from H-6 bomber [PLAAF]
	YJ(KD)-63	160	Unknown	LACM launched from H-6 bomber [PLAAF]
	KD-88	180-200	Unknown	LACM launched from JH-7A fighter-bomber or H-6 bomber [PLAAF]
UAVs	J-6 UCAV	640	Approximately 200 (2008 estimate)	Converted J-6/Mig-19 fighters [PLAAF]
	BZK-005	Long endurance	Unknown	Strategic reconnaissance [PLA General Staff Department (GSD) & PLAN]
	BZK-009	800	Unknown	For strategic reconnaissance, EO/ELINT [PLA GSD]
	ASN-105	100	Unknown	Battlefield ISR [PLA]
	ASN-206	150	Unknown	For battlefield ISR and EW, catapult launched [PLA]
	ASN-104	60	Unknown	Battlefield ISR, first production 1985, rocket launched [PLA]
	Harpy	400-500	Approximately 100, more may have been built	PLAAF anti-radiation drone system with 32 kg warhead
MLRs	PKL-300	100+	Unknown	PLA
	AR-3	220	Unknown	PLA
Fighters	Multiple (J-10, Su-27, Su-30, J-11, J-8, J-7)	Varies	130 (this number could increase rapidly during crisis with aircraft forward deployments)	PLAAF
Bombers/ Attack	Multiple (H-6, etc.)	Varies	200 (total number in PLAAF is 400)	PLAAF

Sources: DoD China Military Report (2013 & 2010), NASIC Ballistic and Cruise Missile Threat 2013, The Military Balance 2013, SinoDefence, Air Power Australia, Andrew Erickson's, "China's Modernization of its Naval and Air Power Capabilities," in *Strategic Asia 2012-13*, Chinese Military Aviation, Phoenix TV, Defence Review Asia

AIRBASE STRIKE CAPABILITY

There is a significant body of Chinese military writings on the employment of missile strikes as a means of establishing air superiority over Taiwan.[37] Illustrating the importance the PLA places on air superiority, the *Science of Military Strategy* argues that strategic air raids "may replace ground operations as the main operations to attain strategic aims. Success or failure…has direct bearing and constraint on the course and outcome of war."[38] In describing the selection of targets for strikes, the authors of the *Science of Military Strategy* state that: "fighter forces are to destroy or contain threatening enemy planes through…blocking enemy airfields."[39] Strategic missile forces, referred to as "striking fires" in PLA materials, would likely play the most critical role in an air raid. The *Science of Military Strategy* describes the use of missiles to attack enemy air power in the following terms: "In terms of striking fires…guided and precision guided missiles are to be used to destroy and suppress the enemy's radar stations, ground air defense weapons, and airfields."[40]

Authoritative Chinese military documents indicate that in the event of conflict the PLA would consider Taiwan's airbases to be the principal targets of its land-based missile units and air force assets. For example, the PLA's *Second Artillery Force Science of Campaigns* lists the primary mission of the Second Artillery's conventionally armed missile units during a coordinated air and missile campaign to be: "suppressing enemy air force airbases, airfields, and missile defense (air defense) systems."[41] According to this source, such operations would be conducted in coordination with air units in order to achieve air superiority. Second Artillery strategists write that:

> *To achieve air superiority, long distance firepower must be applied to "control the air through the ground." Enemy combat aircraft would be suppressed or destroyed on the ground, and/or blockaded inside their bunkers; thus making it difficult for their air combat forces to play an effective role.*[42]

PLAAF appears to have begun developing doctrine for conducting strikes on Taiwan's airbases prior to the Third Taiwan Straits Crisis. In 1995, the PLA Air Force Command College published a book that included a section on airbase strike operations. In the book, *The Application of Air Force Operations*, the authors referred to airbase strikes as

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[37] Note that the PLA typically uses the term "command of the air" [制空权] as a loose substitute for the U.S. Air Force terms "air superiority" or "air dominance." Interestingly, none of the Chinese documents reviewed for this study actually defines or explains the meaning of "command of the air." However, the concept's critical importance is often emphasized. For the sake of simplicity, it is translated here as "air superiority", which is defined as: *That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea and air forces at a given time and place without prohibitive interference by the opposing force*. Of multiple sources, see http://usmilitary.about.com/cs/generalinfo/g/airsu.htm.

[38] Peng Guangqian and Yao Youzhi, p. 321.

[39] Ibid., p. 327.

[40] Ibid.

[41] Yu Jixun, ed., p. 392

[42] Ibid., 398.

"airfield runway blockades" – terminology that is widely used by writers across the PLA today. The authors defined an airfield runway blockade in following terms:

> *The standard of an [airfield runway] blockade is measured according to the loss of the smallest area required for taking off. Once runways have been attacked, the enemy's planes should be unable to find an area sufficient to satisfy the minimum runway length and width requirements for taking off. This is the standard by which to measure the success or failure of a blockade.*[43]

Based on the *Second Artillery Force Science of Campaigns*, a notional operation against Taiwan's air defenses would proceed as follows:[44]

> *First, anti-radiation unmanned aerial vehicles will engage in counter radar attacks. Either at the same time or following this, conventionally armed missiles carrying penetrating submunitions will carry out firepower strikes to cut apart important enemy airfield targets; thereby causing enemy planes to be unable to take-off or land…Afterward, our aviation forces will engage in gap-filling bombing to destroy enemy air combat force ground infrastructure, and take air superiority.*[45]

Numerous supporting research articles, technical studies, and simulation reports indicate that the main focus of airfield strike operations against Taiwan would indeed be airbase runways. Second Artillery researchers argue that:

> *Combat aircraft rely on runways for taking off and landing. Once runways have been destroyed, airfields are unable to provide combat aircraft with fuel, munitions, maintenance and other support. As such, when executing strikes on airfields, runways will be the principal targets.*[46]

Ballistic missiles are generally viewed as the optimal means of delivering airfield runway strikes due to their ability to penetrate enemy air defenses through the use of speed and

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43 *The Application of Air Force Operations* [航空兵作战运筹], (Beijing: PLA Air Force Command College, 1995), cited in Qing Jianjun, et al., "Research on the Application of Air Delivered Dispenser for Blockading Airport Runways [机载布撒器对封锁机场跑道作用仿真研究]," *Dan Jian Yu Zhidao Xue* (Journal of Projectiles, Rockets, Missiles and Guidance), Vol. 24, No. 1, 2004, p. 297.
44 Yu Jixun, p. 398.
45 Yu Jixun, p. 398.
46 See Wang Xiaomei, et al., "Research on Improved Algorithm for Calculating Airport Blockading Probabilities of Submunition Warheads [子母战战斗部对机场封锁概率的改进算法研究]," *Xitong Fangzhen Xuebao* (Journal of System Simulation), April 2009, p. 1859. More recently, a team of Chinese missile designers wrote in a graduate-level PLA textbook that the main target of missile strikes is enemy airfield runways. See Zhang Xiaojin, et al., *Performance Analysis of Missile Systems* [导弹系统性能分析] (Beijing: National Defense Industry Press, 2013), p. 39.

surprise.[47] According to a book produced by the PLA General Armament Department (GAD), ballistic missiles provide the PLA with a means of reducing adversary early warning times. For example, a typical ballistic missile with a 300 kilometer range has a flight time of only 331 seconds (5.51 minutes).[48] Thus, during a surprise ballistic missile attack, Taiwan's air defenses would have little time to react.

Table 2. Ballistic Missile Flight Data

Missile Range (km)	*Highest Altitude (km)*	*Angle of Reentry at 70km*	*Total Flight Time in seconds (minutes)*
300	84.4	25	331 (5.51)
600	164	39	443 (7.38)
1,000	257	40	562 (9.37)
1,500	391	42.1	677 (11.2)
2,000	490	40	789 (13.15)
3,000	700	38.6	989 (16.48)

Source: This table is adopted from Liu Xing (ed.) *Air Defense and Space Defense Information Systems and Their Integrated Technologies* [防空防天信息系统及其一体化技术] (Beijing: National Defense Industry Press, 2009), p.25.

Researchers affiliated with the PLA naval aviation community and the ground force's Army Aviation Academy have also studied airbase strike operations. One of their studies argues that having missile capabilities that could effectively penetrate air defenses to strike enemy airbases would be "an extremely important question in actual combat operations."[49] These researchers assume that if initial barrages of conventional ballistic missiles could not effectively close enemy airbases, bomber fleets and their fighter escorts might be ordered to conduct follow-on surprise attacks. Yet the results of their computer simulations, while not publically available, may have been worse than expected. After reviewing the data, these PLA researchers conclude that more emphasis was needed on ballistic missiles and stand-off missiles to strike enemy airbases, not manned air forces.[50]

PLA studies indicate that a significant amount of simulation and planning has gone into how PLA missile units might engage in strikes on Taiwan's airbases. For example, a study published in 2013 used advanced computer software to simulate strikes on 11 ROC Air Force (ROCAF) bases with ballistic missiles targeting runways. The study's authors

47 Yu Renshun, et al., "Research on Guiding Principles for Blockading Airport Runway using Ballistic Missile with Terminal Course-Correcting Sub-munitions [弹道导弹末制导子导弹封锁机场跑道制导律研究]," *Zhanshu Daodan Jishu* (Tactical Missile Technology Journal), No. 2, 1998, pp. 25-31.

48 Liu Xing (ed.) *Air Defense and Space Defense Information Systems and Their Integrated Technologies* [防空防天信息系统及其一体化技术] (Beijing: National Defense Industry Press, 2009), p.25.

49 Jiang Qingshan, Wu Guoliang, and Fan Botao, "Simulation Study on Blockading Enemy Airfields with Aviation Forces [航空兵封锁敌机场的模拟]," *Huoli Yu Zhihui Kongzhi* (Fire Control and Command Control Journal), October 2005, pp. 33-35, 49.

50 In running the simulation the authors calculated the expected attrition rates required for penetrating a multi-layered enemy air defense zone, and then modeled the launching of ground attacks on airbase runways, control towers, fuel dumps, and parking ramps. They also accounted for enemy air-to-air missile and anti-aircraft artillery attacks on their forces. See Jiang Qingshan, Wu Guoliang, and Fan Botao, p. 49.

argue that the PLA's inventory of missiles is too "limited" and so a simultaneous attack against all of Taiwan's airfields at once is not possible. To mitigate this challenge, the study assesses the respective threat posed by each ROCAF airbase, and then proposes a targeting sequence whereby each base is attacked in order of priority to optimize overall campaign effects.[51]

Based on their simulation results, the authors recommend striking Pingtung Air Base first in order to ground ROCAF's E-2T "Hawkeye" airborne early warning and control (AEW&C) aircraft, and its C-130 "Hercules" military cargo and electronic warfare aircraft.[52] They recommend next striking Hualien Air Base where Taiwan fields its most advanced F-16 fighters.[53] Third in order of priority appears to be Hsinchu Air Base, where it is assessed that Taiwan might station 57 F-5 "Tiger" fighter aircraft variants during a conflict. Airbases in Chiayi and Chiashan, the respective wartime locations of ROCAF F-16 and Mirage-2000 fighter squadrons, follow in order of priority.

Table 3. Order of PLA Strikes on ROCAF Airbases

Strike Order	*Probable Taiwan Airbase*	*Expected Aircraft Types [Aircraft Number]*	*Distance from Notional Fire Unit*
1st	Pingtung Air Base	C-130 [20], E-2T [1], EC-130 [1]	300 km
2nd	Hualien Air Base	F-16 [40], RF-16 [10]	330 km
3rd	Hsinchu Air Base	F-5E/F [48], RF-5E [9]	180 km
4th	Chiayi Air Base	F-16 [60]	185 km
5th	Chiashan Air Base	Mirage 2000 [60]	240 km
6th	Tainan Air Base	IDF [60]	210 km
7th	Dayuan Air Base, Taoyuan	IDF [60]	150 km
8th	Ching Chuan Kang (CCK) Air Base, Taichung	IDF [60]	180 km
9th	Chihhang Air Base, Taitung	F-5 E/F [70]	360 km
10th	Songshan Air Base, Taipei	Boeing [1], IDF [10]	210 km
11th	Kangshan Air Base	AT-3 [52]	300 km

Source: This table is adopted from Tao Guiming, et al. "Modeling the Order of Surface-to-Surface Missile Strikes on Airfields," *Computer and Information Technology Journal*, February 2013, p. 14.

[51] Tao Guiming, et al., "Modeling the Order of Surface to Surface Missile Strikes on Airfields [地地导弹打击机场排序模型]," *Diannao Yu Xinxi Jishu* (Computer and Information Technology Journal), February 2013, pp. 12-14. Note that the authors are affiliated with the Ordnance Engineering Academy's Forth Department in Shijiazhuang, Hebei; the Institute of Electronics in Changsha, Hunan; and the General Armaments Department's Office in the Changsha area, respectively.
[52] Note that the study did not explicitly reference place names, instead it referred to a certain "island region's airfields." The location of each Taiwan airbase is based on the author's assessment of the data provided (for example of 60 IDFs at an airbase 150 km from Chinese launcher). Open source reporting on where the ROCAF deploys its aircraft during wartime, and Google Earth measurements of the distance of each airbase from the PRC coast helped to further narrow the range of possibilities. See tables three and four on page 14 of Tao Guiming, et al.
[53] Tao Guiming, et al. p. 14.

Weapons Development

To meet operational requirements for a Taiwan contingency, the Second Artillery and PLAAF have been investing heavily in a number of specialized weapons for airbase attacks. These weapons include both ground- and air-launched missile variants that are armed with runway penetrating submunitions. Most notably, the Second Artillery appears to have developed the world's first ballistic missile warhead designed for releasing cluster bombs on runways. Chinese military-technical writings indicate that preliminary research in support of this program began in the wake of the Third Taiwan Strait Crisis.

In 1998, the first known Chinese technical study on runway attacks was published by researchers at the PLA's Beijing Artillery Research Institute and the Beijing Institute of Technology. The study models airfield strikes aimed at cratering or "cutting" a 3,000 meter long runway at its mid-point with 15 course-correcting submunitions delivered by a ballistic missile.[54] Shortly thereafter, researchers at the Second Artillery Engineering Academy in Xi'an published a computer simulation they designed to assess the number of ballistic missiles required to successfully blockade an enemy runway.[55] While their results were not made publically available, this study appears to have ignited a heated internal debate on the number of missiles it would take to close a Taiwan airbase.[56]

Most of the Second Artillery research that followed focuses on statistically modeling ballistic missile attacks on single runways with penetrating submunitions.[57] As early as 2000, however, some studies looked at striking large airbases that had two or more runways.[58] In particular, this research focuses on optimizing the process whereby aim-points would be selected for maximizing the effects of dispersed submunitions over multiple runways.[59] Reflecting the technological and budgetary constraints facing the PLA in the late 1990s and early 2000s, these studies assume for poor missile targeting capabilities, and emphasize the need to maximize the effects of a small number of relatively expensive missiles. For example, researchers assumed that even under optimal conditions submunitions could still impact the surface up to 187 meters off

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[54] Yu Renshun, et al., "Research on Guiding Principles for Blockading Airfield Runways using Ballistic Missiles with Terminal Course-Correcting Submunitions [弹道导弹末制导子导弹封锁机场跑道制导律研究]," *Zhanshu Daodan Jishu* (Tactical Missile Technology Journal), No. 2, 1998, pp. 25-31.
[55] Jiang Minle and Gao Xiaoguang, "Computer Simulation of Tactical Missile Attack Operations Effects Against Airfields [战术导弹对机场攻击作战效能的计算机模拟], *Huoli Yu Zhihui Kongzhi* (Fire Control and Command Control Journal), Vol. 23, No. 2, June 1998, pp. 59-62.
[56] Moreover, this debate soon spread to Taiwan, and eventually to U.S. Air Force and Navy circles. More on this will be discussed later in the paper.
[57] Of many sources, see Shi Xilin and Tan Junfeng, "Law of Statistical Calculations for Experiments on Aircraft Runway Loss Rates [飞机跑道失效率计算的统计试验法]," *Huoli Yu Zhihui Kongzhi* (Fire Control and Command Control Journal), Vol. 25, No. 1, January 2000, pp. 74-76.
[58] Shi Xilin and Tan Junfeng, "Firepower Operations for Tactical Surface to Surface Missile Strikes on Complex Aircraft Runways [战术地地导弹打击复杂飞机跑道的火力运用]," *Huoli Yu Zhihui Kongzhi* (Fire Control and Command Control Journal), Vol. 26, No. 2, June 2001, pp. 38-40.
[59] Ibid.

target.[60] They also assumed that cutting runways in half would be the main mission because only a small number of imprecise ballistic missiles would be available for airfield runway blockades.[61]

It was not long before Second Artillery researchers began to evince somewhat greater confidence in their research assumptions. For example, advances in Chinese satellite reconnaissance and sensor data in the early 2000s led researchers at the Second Artillery Engineering Academy's Information Engineering Institute to claim that it was "extremely easy to satisfy" imagery requirements for target guidance. For them, not only airbase runways, but also individual warships docked in military ports could now be targeted.[62] The results of their simulations showed that a payload of 50 submunitions dispersed over a target under favorable conditions could achieve a 3.7% probability of destroying an enemy warship, and a 5.2% probability of destroying targets of importance elsewhere ashore. Though not particularly impressive, their results were considered an improvement over previous simulations that studied strikes against runway targets.[63]

Some challenges may have slowed the pace of warhead development as the program advanced. Technical studies highlight the complexity involved in developing an entirely new class of weapon. In 2007, operations analysts affiliated with the Chinese aerospace industry published a study that shows missile-delivered submunitions would be subject to a number of complicating factors. These factors include the following: wind direction and speed; guidance sensor and engine ignition related positioning errors; guidance sensor errors; internal electrical system and engine timing errors; engine power errors; and warhead spin speed errors.[64] Further highlighting the technical challenges designers face, they emphasize that problems could occur during the flight of the supersonic delivery vehicle (a ballistic missile); or when the "mother" warhead released and dispersed submunitions over target; or when the submunitions' parachutes deployed; or when the munitions impacted the surface.[65]

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[60] However, the average future CEP they envisioned was around 80 meters. See table one in Yu Renshun, et al., 1998, p. 31.
[61] See Jiang Minle and Gao Xiaoguang, 1998; Shi Xilin and Tan Junfeng, 2001; and Xue Wentong, et al., "Computer Simulation of Sub-Munitions Damage Effects against Complex Target Configuration [子母弹对复杂形状目标毁伤效果的计算机仿真]," *Jisuanji Fangzhen* (Computer Simulation Journal), Vol. 20, No. 4, April 2003, pp. 16-18.
[62] See Xue Wentong, et al., p. 17.
[63] Note that the senior researcher involved in this project had previously conducted the computer modeling of conventional ballistic missiles strikes on runways. See Song Guangming and Song Jianshe, "Computer Simulation of Conventional Missile Strikes on Airfield Runway [常规导弹打击机场跑道的计算模拟]," *Huoli Yu Zhihui Kongzhi* (Fire Control and Command Control Journal), Vol. 26, No. 4, 2001.
[64] See Liu Hengjun, et al., "Research on the Runway Blockade Effects of a Type of Terminal Course Correcting Sub-Munitions [一种跑道末修子母弹及其封锁效率研究]," *Dan Jian Yu Zhidao Xuebao* (Journal of Projectiles, Rockets, Missiles and Guidance), Vol. 27, No. 1, 2007, p. 135-140.
[65] Liu Hengjun, et al., pp. 136-137.

A number of detailed Chinese technical studies discuss warhead design requirements for delivering runway penetrating submunitions. Multiple studies affiliated with the Second Artillery define their design requirement as a missile warhead with a circular error probable (CEP) of 100 meters that could disperse 120 submunitions across a runway in circular patterns with a radius of 150 meters.[66] These studies assume that target runways are 3,000 meters long and 60 meters wide, and that to achieve an effective blockade they need to eliminate all clear areas or "windows" on the runway with the dimensions of 400 meters by 20 meters where enemy fighters could attempt emergency take-offs.[67] One technical study reveals an interest in small penetrating submunitions capable of blasting holes into runways with dimensions of 30 centimeters deep and 1.7 meters across. This study stresses the need for obtaining BDA information in order to confirm mission success.[68]

Research teams have sometimes reached different conclusions regarding the expected effects of their warhead designs. For example, one team's simulations found that, assuming optimal performance, only nine ballistic missile warheads with penetrating submunitions would be needed to achieve an effective runway blockade 75 percent of the time.[69] Five years later, however, another team used an "improved algorithm" to show that nine ballistic missiles with the same type of penetrating submunitions would only ensure success 46 percent of the time.[70] To improve the odds of success, some PLA-affiliated researchers have advocated for using more accurate cruise missiles as an alternative to ballistic missiles for delivering runway penetrating submunitions.[71]

Chinese technical studies emphasize the need to strike the same runway with penetrating submunitions on multiple occasions. Indeed, rather than assume for a "one-and-done" strategy, these studies focus on the need to keep airfield runways blockaded over time in the face of skilled enemy rapid runway repair (RRR) teams. In what is almost certainly a reference to Taiwan, one Second Artillery study discusses "an enemy's

[66] For example, see Wang Xiaomei, et al. pp. 1859-1861; and Lei Yuli and Tang Xuemei, "Research on Algorithm for Calculating Probability of Penetrating Submunition Used Against Airfield Runway [侵彻子母弹对机场跑道封锁算法概率研究]," *Xitong Fangzhen Xuebao* (Journal of System Simulation), Vol. 16, No. 9, 2004, pp. 2030-2032.
[67] Ibid.
[68] Yin Zhihong, et al., "Model and Simulation of Air-to-Surface Missile for Airfield Blockade Operations [空地导弹对机场封锁作战建模与仿真]," *Xitong Fangzhen Xuebao* (Journal of System Simulation), February 2008, pp. 583-585.
[69] See Lei Yuli and Tang Xuemei.
[70] See Wang Xiaomei, et al. For more on this debate, see also Guan Baohua, et al., "Calculation of Terminal Course-Correcting Submunitions' Blockade Probability Against Airfield Runway [末修子母弹对机场跑道封锁概率的计算]," *Dandao Xuebao* (Journal of Ballistics), No. 4, 2005, pp. 22-26; and Li Yong, et al., "Simulation and Calculation Research on Terminal Course-Correcting Submunitions' Airfield Runway Blockade Probability [末修子母弹对机场跑道封锁概率计算仿真研究]," *Xitong Fangzhen Xuebao* (Journal of System Simulation), Vol. 18, No. 9, 2006, 2397-2400.
[71] See Zhang Jiansheng and Tian Hongtang, "Research on Airfield Runway Blockade Probabilities when using Cruise Missiles with Submunitions [飞航导弹子母弹对机场跑道封锁概率研究]," *Zhanshu Daodan Jishu* (Tactical Missile Technology Jornal), No. 1, 2009.

very strong (runway) repair capabilities," and expresses concern that "comprehensive killing bombs"[72] may not be available for use against repair teams.[73] The study suggests using multiple salvos of conventional ballistic missiles to disrupt airfield engineering teams and slow the pace of repair work. The most effective way to keep a ROCAF airbase runway closed for two hours, the researchers argue, would be to hit the runway with 18 ballistic missiles fired in three salvos spaced out in 40 minute increments.[74] According to their data, the first salvo would optimally be comprised of 12 missiles, and the next two salvos would have three missiles apiece.[75] Using this technique, the researchers estimate that the Second Artillery could expect an 87 percent chance of success.[76] While speculative, the 18 missile "ceiling" may have been included for conservative planning purposes because that is the most probable number of launchers a single SRBM brigade could be expected to field during a conflict.[77]

Other PLA studies have discussed using hybrid warheads to deliver a mix of penetrating submunitions *and* anti-personnel ordnance to slow airbase recovery teams. A 2013 study found that a "certain enemy" (i.e. ROCAF) could recover from missile attacks and repair a large enough segment of runway to conduce emergency take-off and landing operations in as little as 75 minutes.[78] To extend the length of time target runways remain inoperable, this study suggests using a combination of two types of submunitions working in tandem: one type for cratering runways, and one for creating

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[72] The Chinese term used in the study was: 整体杀爆弹. While unclear, this would appear to be a euphemistic reference to a nuclear bomb or perhaps some other weapon of mass destruction.
[73] Li Xinqi and Wang Minghai, "Research on Standard Problems of Conventional Missile Effects for Blockading Airfield Runways [常规导弹对封锁机场跑道效能准则问题研究]," *Zhihui Kongzhi Yu Fangzhen* (Command Control and Simulation Journal), Vol. 29, No. 4, August 2007, p. 78.
[74] Li Xinqi and Wang Minghai, p. 81.
[75] Other possibilities under consideration included one large 18 missile salvo; two salvos (first 12 missiles and then 6 missiles) separated by 60 minutes; three salvos (10, 4, 4) separated by 40 minutes; and four salvos (8, 4, 3, 3) separated by 30 minutes. These were assessed to have the following chances of success: 74, 82, 82, and 77 percent, respectively.
[76] Li Xinqi and Wang Minghai, p. 81.
[77] This hypothesis may also help explain the artificial two hour planning assumption used by this and other Second Artillery studies. Indeed, during wartime, ballistic missile launch units within a brigade would likely require 90-120 minutes to safely fire, relocate, reload, and fire again. However, it should be noted that there could be many other potential explanations for why this study uses 18 ballistic missiles as its baseline for planning purposes. Perhaps it is assumed that other missile launchers within a launch brigade will be diverted for attacks on command posts and radar sites. It could also be assumed that more than 18 launchers would be unavailable at any given time because of adversary strikes or force management issues such as periodic maintenance.
[78] Huang Guangyan, et al., "Method for Assessing Effects of Joint Anti-Runway and Area Blockading Sub-munitions [反跑道与区域封锁子母弹联合对封锁效能的评估方法]," *Dandao Xuebao* (Journal of Ballistics), March 2013, p. 46. Note that this study was funded by a combination of the PRC's National Natural Science Grant (11102023) and an in-house grant from China's State Key Laboratory on Explosion Science and Technology at the Beijing Institute of Technology (YBKT12-02). See also Huang Hanyan and Wang Zhengming, "Calculation and Analysis of Cluster Munitions Effects on Airstrip Blockade Times [子母弹对机场跑道封锁时间的计算方法与分析]," *Binggong Xuebao* (Acta Armamentarii Journal), No. 3, 2009. Note that this study was funded by the National Natural Science Grant, and a National University of Defense Technology program grant.

hazards to runway repair crews and fighter aircraft attempting emergency take-offs.[79] Using this method, the authors estimate that adversary runway repair times could be extended from 75 minutes up to 98 minutes.[80]

Weapons Testing

Reports indicate that the PLA has moved beyond initial research, development, and simulation work, and has actually been testing a number of weapon types for attacking airfields. Perhaps the first reported instance came in September 2005, when Taiwan intelligence analysts discovered that the PLA had constructed a mock airbase on Daluo Island off the Guangdong coastline for target practice.[81] This model airbase included a fuel storage facility, two mock F-16 fighters, aircraft hangars, and an alert station at the end of the runway. Soon thereafter, Taiwan satellite imagery revealed that the entire base was destroyed with munitions that created large craters. According to the report, two months later the Second Artillery conducted a cruise missile strike on a mock-up hardened aircraft shelter (HAS) target in Xinjiang, hitting it three times.[82]

In 2006, it was reported that the PLA had built a mock Taiwanese airbase in the desert of Gansu Province. Based on satellite imagery of the mock-up, which is modeled after Taichung's CCK Air Base, this site is primarily used to practice air and missile raids.[83] Built near the PLAAF's Dingxin Air Force Test and Training Base (also known as Shuangchengzi Air Base), this area is used for PLAAF air-to-air and air defense training as well as GAD/Second Artillery missile testing.[84] Other mock airbase targets have also been constructed in the deserts of Western China, including one that resembles Kadena Air Force Base on Okinawa.[85]

One report in the PLA Daily suggests that the Second Artillery has been experimenting with cluster munitions capable of spreading proximity mines around test ranges.[86] While speculative, these munitions could have been test versions of those being developed for slowing rapid runway repair crews. Whatever the case, cluster bombs with

79 Huang Guangyan, et al., p. 46.
80 Ibid.
81 Gao Zhiyang, "Beyond Runway Recovery – the New Thinking on Passive Airfield Defense [搶修跑道之外--機場被動防禦的新思維]," *Quanqiu Fangwei Zazhi* (Defence International), May 2006, accessible online at http://www.diic.com.tw/mag/mag261/261-38.htm.
82 Ibid.
83 Carolyn O'Hara, "China builds a mock Taiwanese air base," *Foreign Policy*, August 11, 2006, at http://blog.foreignpolicy.com/posts/2006/08/11/china_builds_a_mock_taiwanese_air_base.
84 See David Axe, "China's Increasingly Good Mock Air Battles Prep Pilots for Real War," *Wired Magazine*, February 7, 2013, at http://www.wired.com/2013/02/china-mock-air-war/all/. For a good map of the facility, see "Dingxin/ Shuangchengzi Air Base," at http://wikimapia.org/835014/Dingxin-Shuangchengzi-Air-Base.
85 Authors interviews with U.S. Air Force officer and Japanese MoD official in Washington D.C., July 2014. See also Ray Walters, "China's mysterious desert lines mystery solved," *Geek*, November 15, 2011, at http://www.geek.com/geek-cetera/chinas-mysterious-desert-lines-mystery-solved-1441125/.
86 See Wang Tie, et al., "Second Artillery Missile Warhead Storage Facility Cracks Critical Technologies [二炮导弹战斗部洞库贮存关键技术已经破解]", *Jiefangjun Bao* (PLA Daily), April 12, 2007, available online at http://mil.eastday.com/m/20070412/u1a2760363.html.

delayed fuses have proven nearly fatal to Second Artillery warhead engineers collecting data on the ranges.[87] The first confirmed live-fire test of an actual ballistic missile warhead designed to disperse runway penetrating submunitions occurred more recently. In early 2010, a warhead design team from the Second Artillery Equipment Research Academy published a report on the results of their live fire testing on a mock runway target to confirm optimal warhead design parameters.[88]

Beyond ballistic missile warheads developed for Second Artillery use, the Chinese defense industry has produced stand-off weapon systems for the PLAAF as well as export customers. Two examples include the stealthy air-launched TIANLEI and CS/BCC5 cruise missiles which are designed to deliver submunitions through adversary air defense systems. Currently, these missiles are believed to have a range of 60 kilometers and 500 kilogram warheads for runway strikes.[89] The Chinese defense industry has also displayed a PLA ground force artillery launch system capable of firing WS3A guided rockets up to 280 kilometers. Apparently still in development, this rocket launcher is intended to deliver a mix of penetrating warheads and cluster munitions for area attacks. At a Chinese air show in 2012 these rockets were shown on a video simulation blowing up parked Taiwanese F-16 fighters at Hualien Air Base.[90]

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87 Huang Guangyan, et al.

88 Jiang Zengrong, et al., "Numerical Modeling of Blast Depth Influence on Destruction Effects of Runway Penetrating Warhead [炸点深度对反跑道侵爆战斗布摧伤效果影响数值模拟]," *Conference Paper Presented at China's Ninth National Forum on Blast Dynamics*, undated, pp. 175-179; and Jiang Zengrong, et al., "Numerical Modeling of Blast Depth Influence on Destruction Effects of Penetrating Warhead [炸点深度对侵爆战斗布摧伤效果影响数值模拟]," *Binggong Xuebao* (Acta Armamentarii Journal), April 2010, pp. 28-31.

89 Xiao Feizhu, "*Tianlei* and CS/BCC5 Type Munitions Dispensing Systems Unveiled at Our Nation's Aerospace Expo [我国航展亮出天雷和 CS/BCC5 两种弹药撒布系统]," *Baxue Net*, November 13, 2012, at http://www.baxue.com/zhongguojunqing/18828.html.

90 "Window into China Air and Space Technology Exhibition [中國航空航天科技櫥窗室內展場]," *Quanqiu Fangwei Zazhi* (Defence International), No. 340, December 2012, pp. 33-36.

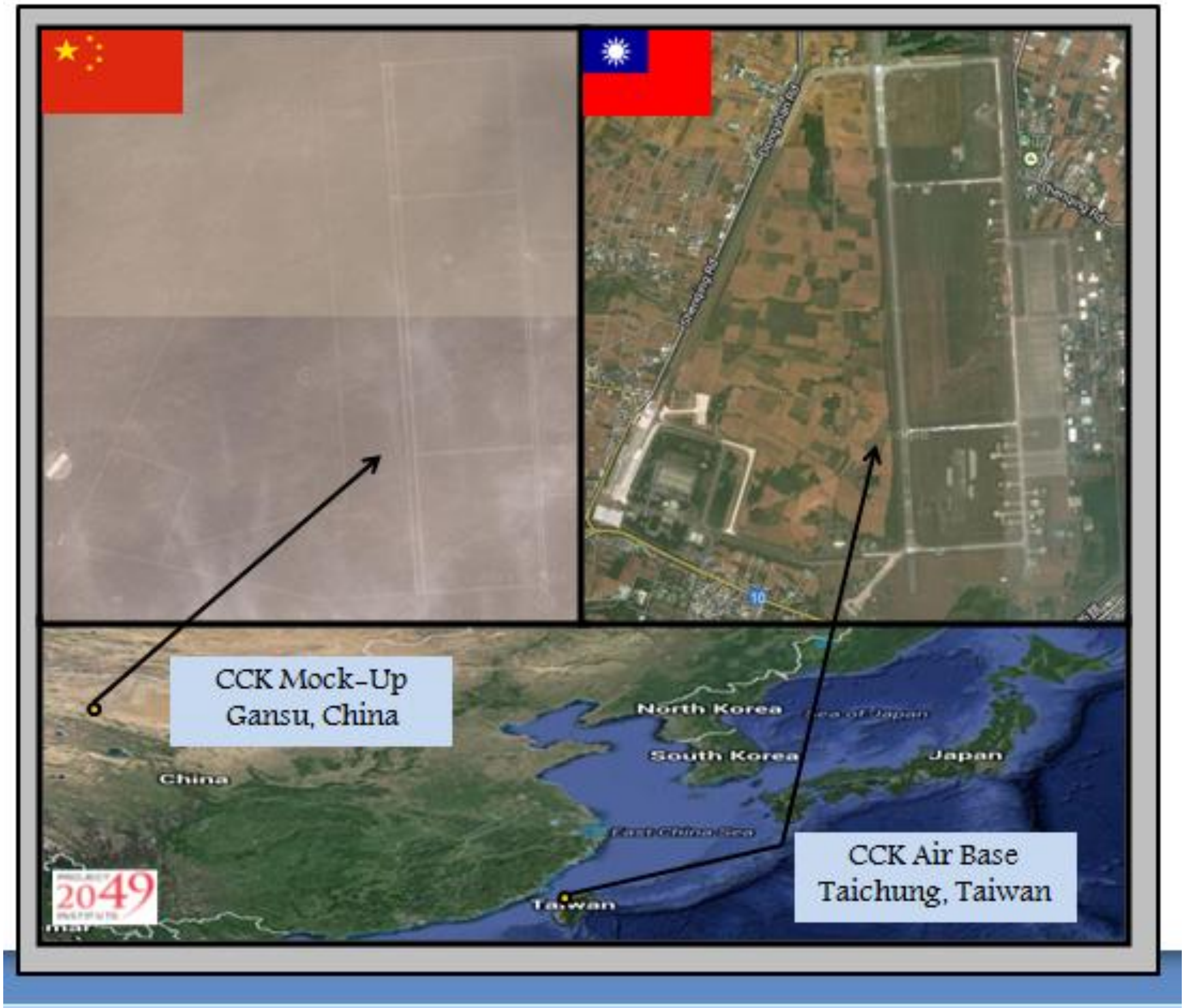

Figure 3: CCK Air Base Mock-up and Actual CCK Air Base (Source Google Maps).

Taiwan Threat Assessments

Taiwanese military analysts and engineers have closely studied the PLA's development of airbase runway attack capabilities. Their early research focuses on the threat of Chinese air strikes, and advocates that ROCAF develop an automated airbase defense network that includes surface-to-air missiles (SAMs), air defense guns, early-warning aircraft, RRR crews, and redundant radar sites.[91] More recently, a large number of studies have used computer simulations to assess the damage conventional ballistic missiles could cause to ROCAF airfield runways.[92]

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[91] See Lee Zne-Jung, "Study on the Decision Support System of Electronic Defense [電子防禦網決策支援系統之研究]," *Kangning Xuebao* (Academic Journal of Kang-Ning), No. 5, June 2002, pp. 185-198.

[92] See Liu Horng-Di, *Applying Monte Carlo Method in Military Operations-Assessing the Situation of Ballistic Missile Attacks on Airfields* [蒙地卡羅法在軍事作業之應用—評估彈道飛彈攻擊機場之情況]

One somewhat controversial study found that it would take 50 to 70 ballistic missiles to "lightly damage" a single Taiwan airbase runway, and over 210 ballistic missiles to ensure "heavy damage."[93] In contrast, a much more pessimistic study found that, assuming very precise missiles and flawless warhead effects, it would only take a salvo of six SRBMs to achieve an 84 percent probability of blockading an airfield runway.[94]

The main reason so much variance exists in these and other simulation results is the debate over the expected precision of attacking missiles. Currently, the Second Artillery's ballistic missiles appear to have increasingly low CEPs. Assessments show that some unitary warheads have CEPs around 40 meters, and submunitions-delivering warheads have CEPs that range from approximately 70 to 100 meters.[95] Yet, it is difficult to assess how large the Second Artillery's stocks of these more precise missile warheads are, and it is not clear how fast the PLA will be able to develop and deploy more advanced warhead variants.

Moreover, researchers tend to vary greatly in their assumptions regarding how many PLA missiles could penetrate Taiwan's BMD shield. Here the performance of intercepting missile units is critical. The effects of electronic jamming directed at incoming warhead guidance systems is also an important variable.[96] While many unknowns remain, Taiwanese researchers have effectively highlighted the growing challenge their nation faces in defending airbases from PLA missile strikes.

To meet this challenge, Taiwan's operational research community has undertaken a number of projects on countering PLA missile strikes. In particular, advanced

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(Taichung, Taiwan: Feng Chia University Master's Thesis, 2006), pp. 1-134; 孟昭宇、劉達生、劉基全, "Monte Carlo Model of Airfield Runway Damage from Ballistic Missile Attacks [以蒙地卡羅模擬進行機場跑道遭彈道飛彈攻擊之損]," presented on August 8, 2007 at *Fourth Annual ROC Military Conference on Military Operational Research and Modeling*, Conference Proceedings, pp. 244-258; and 劉達生 et al., "Airfield Runway Blockade Time and Assessment: Applying Monte Carlo Modeling [機場跑道封鎖時間之評估：應用蒙地卡羅模擬法]," presented on May 22, 2009 at the *85th Annual Army Academy Anniversary Forum on Infrastructure Studies*, Conference Proceedings, pp. 307-316.

93 See 孟昭宇、劉達生、劉基全, "Monte Carlo Model of Airfield Runway Damage from Ballistic Missile Attacks [以蒙地卡羅模擬進行機場跑道遭彈道飛彈攻擊之損]," presented on August 8, 2007 at *Fourth Annual ROC Military Conference on Military Operational Research and Modeling*, Conference Proceedings, pp. 244-258. For the Mainland Chinese reaction to this study, see Li Dong (ed.), "Taiwan says Mainland Needs 200 Missiles to Blow-up 1 Runway [台称大陆 2 百导弹炸 1 跑道]," *China Net*, September 26, 2007, at http://www.china.com.cn/news/txt/2007-09/26/content_8953220.htm.

94 See "Research on Damage Assessment of Ballistic Missile Attacks on Airfield Runway [彈道飛彈攻擊機場跑道損害評估之研究]," *Ministry of Education Military Training and National Defense Education Thesis*, undated, p.59, at http://defence.hgsh.hc.edu.tw/awardlist/pdf/102-11.pdf.

95 Authors interview with defense intelligence official in Washington D.C., June 2014.

96 For an example of a nuanced and fair treatment of the SRBM threat to ROCAF airbase runways, see Hsu Li-Ling, *Analysis of Ballistic Missile Attack on Airfield Runway* [彈道飛彈攻擊機場跑道之分析], (Taichung, Taiwan: Feng Chia University's Graduate Institute of Industrial Engineering, 2010).

technology laboratories within Taiwan's National Defense University have conducted operational analyses to explore the options available to ROCAF for keeping its runways operational while under missile attack.[97] The most detailed publically available studies focus on improving rapid runway repair capabilities and reducing the minimum operating surfaces required by aircraft for taking-off and landing.[98]

One technical research project assumed that Taiwanese fighter aircraft require approximately 900 meters of runway to safely take-off and land. As a result, this study found that the Second Artillery could achieve a 74 percent chance of blockading a large Taiwan airfield runway with 32 SRBMs.[99] However, the study assessed that if ROCAF could reduce its minimum operating strip requirement to 500 meters, the Second Artillery would require 63 SRBMs to have a 71 percent chance of blockading the same runway.[100] An overview of the ROC military's technical research demonstrates that a fierce intellectual competition is underway to deny the PLA air superiority in a conflict.

Taiwan's operational research efforts appear to have been overlooked in the U.S., where most defense analysts have reacted to the PLA development of precision strike capabilities for targeting airbases with a sense of alarm. For example, William Murray, a distinguished professor at the U.S. Naval War College, wrote in a 2008 article that "something between a hundred and two hundred unitary warheads could deny Taiwan the use of its airbases for a while,"[101] and "Taiwan can do little to prevent a Chinese bombardment by hundreds, even thousands of precision munitions."[102] Likewise, analysts at the RAND Corporation assessed that "the threat to Taiwan from Chinese ballistic missiles is serious and increasing…although literally thousands of missiles might be needed to completely and permanently shut down Taiwan's air bases, about

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[97] For example, see Chen Yi-Wen, *The Runway Blocking Operation Assessment under Tactical Ballistic Missile Attack* [彈道飛彈封鎖機場跑道模型之建構] (Taoyuan, Taiwan: National Defense University Master's Thesis, 2009), pp. 1-110. See also Hsu Chung-Lung, *Promoting the Rapid Runway Repair Operating Procedure of ROC Military Airport* [提昇軍用機場跑道鋪面緊急搶修作業之研究] (Pingtung, Taiwan: National Pingtung University of Science and Technology, 2009), pp. 1-112.
[98] See Yi Jia-Hong, *A Study on Decision Support for Minimum Operating Strip Selection in Rapid Runway Repair* [機場跑道緊急搶修最小起降帶挑選決策輔助之研究] (Taoyuan, Taiwan: National Defense University Master's Thesis, 2010), pp. 1-86; and Sung Jen Da, *Research on Applying Management and Maintenance System for Establishing Military Airfield Runway Pavement Emergency Repair* [軍事機場跑滑道鋪面緊急搶修暨建立使用管理與維護制度之研究] (Taoyuan, Taiwan: National Defense University Master's Thesis, 2004).
[99] Hsu Li-Ling, *Analysis of Ballistic Missile Attack on Airfield Runway* [彈道飛彈攻擊機場跑道之分析], (Taichung, Taiwan: Feng Chia University's Graduate Institute of Industrial Engineering, 2010), p. 51.
[100] Ibid., p. 53.
[101] William S. Murray, "Revisiting Taiwan's Defense Strategy," *Naval War College Review*, Summer 2008, Vol. 61, No. 3, p. 23, accessible online at: https://www.usnwc.edu/getattachment/ae650b06-a5e4-4b64-b4fd-2bcc8665c399/Revisiting-Taiwan-s-Defense-Strategy---William-S--.aspx.
[102] Ibid., p.25.

60-200 submunition-equipped SRBMs aimed at operating surfaces would seem to suffice to temporarily close most of Taiwan's fighter bases."[103]

These pessimistic reports conclude that the balance of airpower in the Taiwan Strait is shifting toward the PRC. These conclusions should galvanize a joint U.S.-ROC effort to address the dynamic airpower balance in the Western Pacific. Instead, these well-intended studies could be misinterpreted as implicit support for Beijing's position: that the U.S. should curtail its arms sales to Taiwan. Because Taiwan's airbases are vulnerable to attack, as the narrative could go, the U.S. should deny the ROC's well-established requirement for additional new fighter jets.

This situation underscores the need for U.S. policymakers to closely examine Taiwan's legitimate defense needs in light of its broader strategy. As the following section will demonstrate, Taiwan is doing more to defend itself from PLA missile and air strikes than any other country in Asia. Taiwan's experience offers valuable insights to other regional air forces, including the Japanese Air Self Defense Force and the Republic of Korea Air Force, which face a potential threat from Chinese long-range precision strike capabilities. The U.S. Air Force (USAF), which operates airbases that are perhaps the most vulnerable to long-range missiles, may draw lessons from Taiwan's experience to improve the resiliency of its facilities as well.[104]

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[103] David A. Shlapak, et al., *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Arlington, VA: RAND Corporation, 2009), p. 51, accessible online at: http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG888.pdf.
[104] This paragraph draws from the author's interviews with Japanese officials at Naha Air Base in Okinawa, and at MoD in Tokyo, August and September 2013; and author's interviews with U.S. Air Force and Marine Corps officials at Kadena Air Base and Futenma Marine Corps Air Station in Okinawa, November 2013.

TAIWAN MILITARY RESPONSE

To deny the PLA uncontested air superiority in a future conflict, Taiwan is working with the United States to construct one of the most resilient command and control, and air and missile defense systems in the world. Taiwan is further improving this network with indigenously developed systems that are less vulnerable to external factors such as the vagaries of arms sales. Taiwan's air and missile defenses factor into the survivability and resiliency of its critical defense infrastructure, including its airbases. More than an operational issue, enhancing airbase survivability is important for crisis stability and reducing PLA confidence in victory. Resiliency has the potential to shift the PRC's strategic calculus sufficient to deter a war.[105] This section describes how the ROC military has responded to the PLA precision strike threat by building a defensive shield that includes a powerful combination of both active and passive defense elements.

Active Defense

Active defense refers to the employment of interdiction, limited offensive action, and counterattacks to protect a friendly air, land, or sea platform or deny a contested area or position to the enemy. In the Taiwan context, active defense begins with ISR assets, including a diverse range of radar systems, signals intelligence (SIGINT) and cyber reconnaissance, and human intelligence networks for indications and warning of hostile actions. Taiwan faces an adversary that is close to its territory and equipped with multiple strike assets and an offensive first strike doctrine. As a result, the ROC leadership places a premium on vigilance to avoid strategic and operational-level surprise. Here, ISR is critical.

Should PLA missile brigades move out of garrison, and missiles or aircraft are detected heading toward or already within its sovereign airspace, Taiwan's active defense network offers capabilities for responding before they can strike their intended targets. Interception capabilities include tactical fighter aircraft, SAMs, and air defense guns. The purpose of these platforms is to destroy all incoming missiles or aircraft, and protect their targets from attack. In the event of saturation attacks, the objective of these interceptors would be to eliminate a large enough fraction of the incoming missiles or aircraft for Taiwan's passive defense measures (such as base hardening) to be effective.

After sustaining and surviving a first strike, Taiwan would respond with counterstrikes of sufficient power to complicate and if possible disable further PLA operations. The most cost effective way to defend against missiles and aircraft is to destroy them on the ground. By targeting the command and control centers responsible for coordinating operations, Taiwan may be able to paralyze the PLA reconnaissance-strike complex and affect a "mission kill" against it. For counterstrike operations, Taiwan has a growing force of surface-to-surface missiles, stand-off weapons, and guided rocket launchers that can target PLA strike assets at their point of origin. In addition, Taiwan has special operations units that can be covertly inserted into the Chinese mainland to further disrupt PLA operations on the ground. Each of these active defense capabilities will be examined in turn.

[105] The author is indebted to Dr. Oriana Skylar Mastro for this point.

Radars. Taiwan's air and missile defense network is a critical element of the nation's defense. Surveillance and early-warning is provided by a dense array of radars that are positioned in locations that maximize Taiwan's mountainous geography to extend operational ranges. Taiwan's radar network offers a high degree of overlapping coverage to provide the sharing of targets as well as redundancy in case of combat attrition. It also features the unique application of radars that are built into hardened bunkers designed to elevate survivability against PLA missile strikes.[106]

ROCAF is believed to oversee some 20 fixed early-warning radars sites, and 10 mobile early-warning radar units (plus reserve and airfield units), for a total of nearly 50 air surveillance radars. Taiwan is also developing and deploying passive radar systems.[107] PLA authors believe that radar tracking data is integrated into four regional operations control centers (ROCCs), with a central ROCAF Air Operations Center (AOC) in Taipei. The ROCCs function as back-ups and offer redundancy. At least one facility is reportedly located inside a large "super hard" underground facility near Hualien on Taiwan's east coast. Other missile warning centers, according to PLA writings, are thought to be located in the mountains north of Taipei, and at Makung Air Base in the Penghu Islands.[108] PLA analysts assert that ROCAF mobile radar units are stationed at Eluanbi and Taitung in the south of Taiwan, and on Kinmen Island off the coast of Mainland China near Xiamen, although the location of most mobile radar units is unknown.[109]

Taiwan's ground-based radars are linked with six American-built E-2 "Hawkeye" AEW&C aircraft to provide a common operational picture.[110] This combination of surface and airborne radar assets gives Taiwan greatly improved air surveillance capabilities, and increased warning times during periods of high tension or conflict. According to one internal assessment, as early as 2008 ROCAF's integrated air and

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[106] For an excellent overview of Taiwan's air and missile defense network, see Sean O'Connor, "Taiwan's SAM Network," *IMINT and Analysis*, May 5, 2009, at http://geimint.blogspot.com/2009/05/taiwans-sam-network.html.

[107] For a detailed PLA perspective on Taiwan's air defense network, see PLA General Staff Department 54th Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," *Informatized War and Information War Information Compilation Series*, No.2. October 29, 2008, p. 34. According to this source, Taiwan's radar network includes two U.S. AN/FPS-117 radars, two HR-3000 (upgraded HARD) radars, one GE-592 radar, one TPS-40(V) radar, and a number of low altitude surveillance radars. It also includes Taiwan's indigenous CS/MPG-35 mobile tracking radars, CS/UPS-700 search radars, and CS/UPS-60(X) C surface based mobile radar – as well as U.S. AN/TPS-43E mobile early-warning radars.

[108] For a detailed PLA assessment of ROCAF organizational infrastructure, see Bai Chun and Zhang Wenchao, "Brief History of Taiwan's Air Force Development [台湾空军发展简史]," *Dongnan Ya Zhi Chuang* [Window to Southeast Asia], Vol. 22, No. 2, 2013, p. 44. Note that the first author is the director of the Nanjing Political Academy's Military History Office, and the second is a political officer with the PLA's 61902 Unit.

[109] Ibid.

[110] See "National Military's Principal Airborne Early Warning Force: Visit to 2nd Early Warning Aircraft Squadron [國軍空中預警主力: 第 2 預警機中隊專訪]," *Quanqiu Fangwei Zazhi* (Defence International), No. 331, March 2012, p. 38-45; and Gao Zhiyang, "Taiwan's Command and Control System Exposed [台灣指管系統暴光]," *Quanqiu Fangwei Zazhi* (Defence International), No. 319, March 2011, p. 10-13.

missile defense system's radar network was viewed by the PLA as posing a large and growing problem. The assessment states the following:

> *The integration of Taiwan's land-based radars and E-2T early-warning planes has allowed the Taiwan military's early-warning coverage to expand to a distance of 750 nautical miles from Taiwan Island. In Mainland China, from Zhejiang in the north to Guangdong in the south and the Jiangxi and Hubei in the west, all of our military's activities are under their close surveillance. At the same time, all their high altitude detection coverage zones overlap to a high degree, making it very difficult for our military aircraft to penetrate their defenses.*[111]

In late 2012, ROCAF introduced a new ultra high frequency (UHF) radar into its early-warning system. Also known as the Surveillance Radar Program (SRP), this large system is located on top of a strategically situated 2620 meter (8590 ft) mountain in northwest Taiwan.[112] With development overseen by the U.S. Air Force, the SRP is a significantly modified version of the AN/FPS-115 "Pave Paws" ballistic missile defense radar. The radar is capable of tracking air breathing targets within line of sight of the elevated radar, and ballistic missiles launched from locations deep inside China.[113] Theoretically, software modifications could enable the radar to track PRC satellites, space debris, and other space systems. Reports indicate that the system, in terms of track capacity and ability to detect low observable flight vehicles, may be the most powerful ground-based radar system ever built.[114] The system, rather than a tactical air surveillance asset, is intended for peacetime surveillance and strategic early-warning. While its air breathing capabilities offer only marginal advantages over other surveillance radars based on off-shore islands, the system has the potential to make a significant contribution to a common regional air picture, allowing a better understanding of PLAAF training within coverage of the radar, particularly if used in combination with other air surveillance and SIGINT systems.[115]

Chinese military analysts have expressed significant concern regarding this radar's capabilities, referring to it as a potential "holy weapon" against PLA missile forces.[116] Their writings note that Taiwan was the first foreign customer allowed access to this cutting-edge U.S. technology, and speculate that the radar's design could allow for a

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[111] General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," p. 35.

[112] See Li Min, "Taiwan's 'Pave Paws' Revealed [透视台湾铺路爪]," *Bingqi Zhishi* (Ordnance Knowledge), No. 6, 2013, pp. 56-59.

[113] Wendell Minnick, "Taiwan BMD Radar Gives Unique Data on China," *Defense News*, November 26, 2013, at http://www.defensenews.com/article/20131126/DEFREG03/311260013/Taiwan-s-BMD-Radar-Gives-Unique-Data-China.

[114] Ibid.

[115] Author's interviews in Taipei and Arlington (VA), March and April, 2014. See also, "A Dossier on the Pave Paws Radar Installation on Leshan, Taiwan," *Federation of American Scientists*, updated March 8, 2013, accessible online at http://www.fas.org/man/eprint/leshan.pdf.

[116] See Li Min, "Taiwan's 'Pave Paws' Revealed [透视台湾铺路爪]," *Bingqi Zhishi* (Ordnance Knowledge), No. 6, 2013, pp. 56-59.

tracking capability against PLA stealth aircraft.[117] While its size renders it vulnerable, the system remains a difficult target. Operating in the UHF portion of the frequency spectrum, the radar is thought to preclude terminal phase targeting by anti-radiation (counter-radar) missiles.[118] The PLA is believed to have deployed jamming systems that could degrade the radar's range. However, its power enables a high degree of burn through. In terms of hardening, Taiwan's SRP complex is reportedly supported by underground facilities that include fuel storage tanks, back-up power generators, large water supply tanks, and living quarters.[119] Moreover, the complex is protected by an advanced radar-decoy system; point air and missile defenses; and built-in resiliency measures that are designed to allow the radar system to operate even after 30 percent of its components are destroyed.[120]

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[117] Ibid.

[118] Ibid. While speculative, it may be that anti-radiation missile seekers are not large enough to home in on an UHF target. The power output of the radar itself may also be sufficient to damage or destroy fragile microelectronic components in missile seekers. According to one well-placed military officer, the large supply of electric power required to operate the radar is so expensive that the ROCAF generally only operates it on full power for 12 hours a day during peacetime. Given the infrequency of PLA nighttime air activity, this makes some sense. However, it also highlights the budgetary pressure that the ROC military is currently under. Authors interviews in Taipei with U.S. and Taiwan military officials, June 2014.

[119] Ibid.

[120] Ibid.

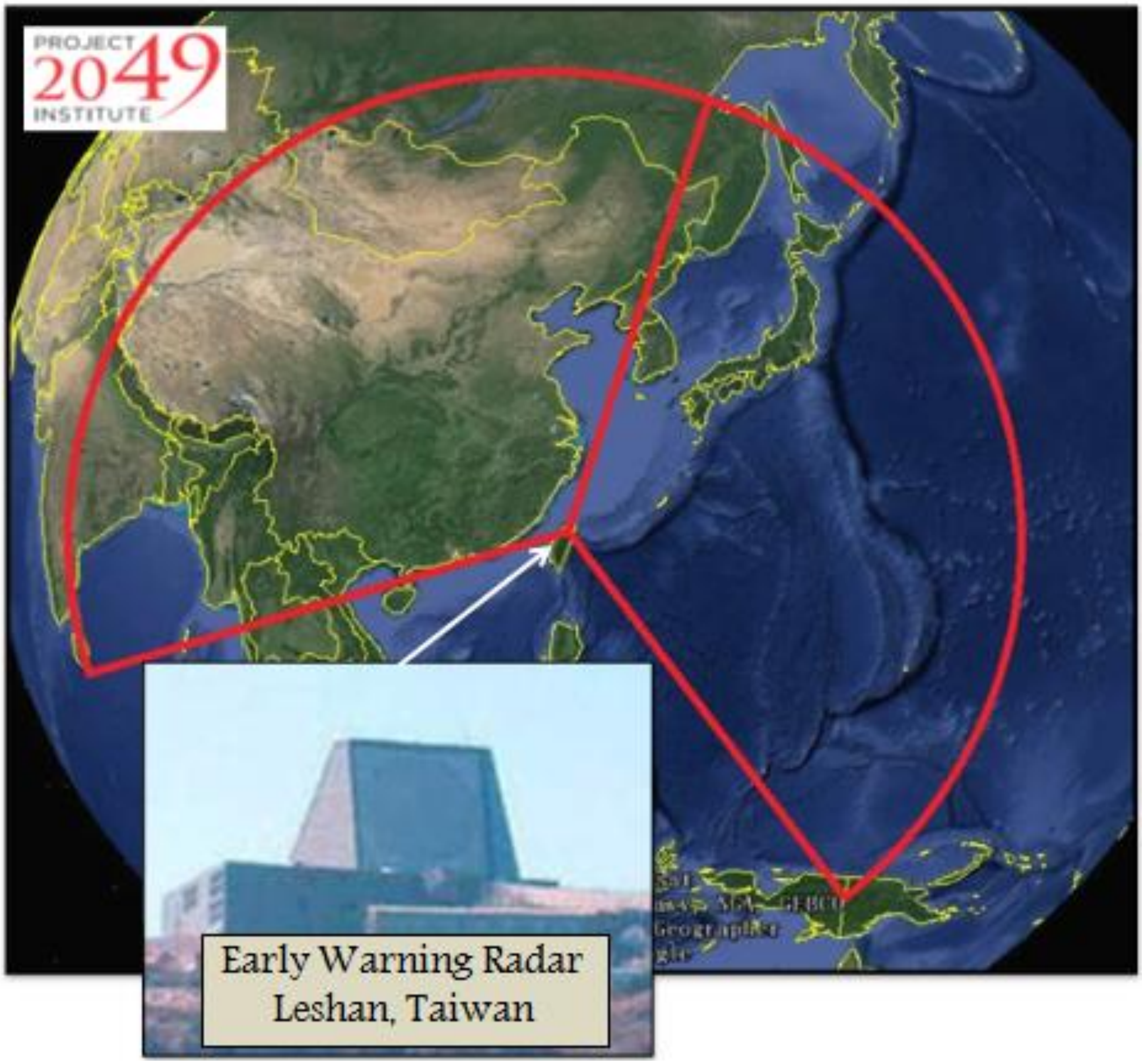

Figure 4: Estimate of SRP Coverage (Source: *Bingqi Zhishi*, No. 6, 2013).[121]

According to PLA GSD analysts, the UHF radar's relative resiliency is not unique. Taiwan's command and control centers, mobile radars, and supporting infrastructure have reportedly been located in underground facilities.[122] These analysts state that defensive measures have given Taiwan's radars "very strong" camouflage and survivability.[123] Yet they note that radar arrays on high-mountain peaks cannot be easily hidden or moved, and missile and air strikes on Taiwan's transportation grid could

[121] While not pictured here, it should be noted that the SRP also has coverage over the South China Sea.
[122] PLA General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," p. 38.
[123] Ibid.

significantly complicate radar dispersal or repair operations.[124] To undercut PLA planning for strikes on radar sites, Taiwan has surveyed and prepared back-up sites where it can move otherwise vulnerable radar systems during periods of high-tension.[125] In addition, communications networks are being installed to connect isolated repair teams to centrally located maintenance experts.[126] Taiwan's air defense network is further bolstered by ROC Navy (ROCN) surface ships that can gap-fill as needed with onboard air surveillance radars.[127] Moreover, Taiwan has a number of early-warning capabilities that are independent of its radar networks, most notably, those derived from its signals and human intelligence networks.

Intelligence. Providing advanced warning of PRC preparations for an attack on the ROC or its principal security partner, the United States, and providing warning that an attack may be underway are the highest priority for all Taiwanese information collection platforms. Indications and warning (I&W) is essential during peacetime to prevent the PRC from obtaining the advantage of surprise. As has been demonstrated repeatedly over the past two decades, I&W information is especially critical during periods of crisis or limited conflict to provide strategic warning of the imminence of attack or the escalation of armed hostilities. Taiwan's timely and reliable I&W greatly contributes to good decision-making, allowing leaders to take appropriate steps ranging from increasing the readiness levels of forces to activating contingency plans.[128] Information about PRC activities obtained from Taiwan's early-warning radar systems is combined with information collected by other sources as a basis for action by Taiwanese and American decision-makers. Several intelligence capabilities fielded by Taiwan have the potential to contribute important I&W information.

Taiwan operates significant SIGINT infrastructure capable of collection on the intentions, activities, and capabilities of the PRC's military and security forces.[129] Taiwan exploits a large number of listening posts, its close proximity to Mainland China, and its world-class information and communications technology expertise for collecting

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[124] Ibid., p. 39.
[125] Sean O'Connor, "Taiwan's SAM Network."
[126] Author's interviews with retired USAF officer involved in the program, Arlington (VA), March 2014.
[127] Sean O'Connor, "Taiwan's SAM Network." See also Gao Zhiyang, "Taiwan's Command and Control System Exposed [台灣指管系統暴光]," p. 11-13.
[128] However, it must be noted that ROC (and U.S.) abilities to provide warning based on traditional, observable military-based indicators has been somewhat weakened since the late 2000s because (1) PLA modernization is reducing its need to forward deploy forces during a conflict, and (2) the PLA is more prepared than in the past to rapidly mobilize for several different military campaigns due to improvements in proficiency and readiness.
[129] Gao Zhiyang, "Taiwan's Command and Control System Exposed [台灣指管系統暴光]," p. 13; Wendell Minnick, "Spook Mountain: How US Spies on China," *Asia Times*, March 6, 2003, at http://www.atimes.com/atimes/China/EC06Ad03.html; and Wendell Minnick, "Taiwan-US Link Up on SIGINT," *Jane's Defence Weekly*, January 24, 2001, at https://www.fas.org/irp/news/2001/01/jdw-taiwan-sigint.html. For a highly detailed account, see Guo Nairi [郭乃日], *The Unseen War in the Taiwan Strait* [看不見的台海戰爭] (Xizhi, Taiwan: Gaoshou Publishing, 2005), pp. 16-30.

SIGINT.[130] Further enhancing its favorable position, Taiwan reportedly was the first country in the world to establish a cyber warfare command.[131] Taiwan's ability to penetrate PLA systems benefits from its well-regarded computer hacking and computer security communities–as well as its commanding position on the supply chains that support the PRC's electronics and computer technology industries.[132] While direct comparative analysis is unavailable due to the opaque nature of the subject, anecdotal evidence suggests that Taiwan's computer hardware and software engineering talent continues to outpace competition in the PRC.[133]

The ROC government has a long history of leveraging its close cultural, linguistic, and economic ties to the PRC for collecting traditional human intelligence (HUMINT). Western media reports generally focus on the Chinese intelligence threat to Taiwan, while overlooking Taipei's impressive track-record of penetrating high-level targets in Beijing. Some sources suggest that Taiwan's HUMINT capabilities in the PRC are the most effective in the world.[134] Counterintelligence experts and retired government officials note that, despite the massive collection efforts aimed at it, Taiwan has been more successful at protecting classified information than South Korea and Japan.[135] Examples of intelligence success include Taiwan's collection of detailed information on the DF-31 ICBM, the Second Artillery's first ASBM and DF-16 brigades, and PLAAF's drone and airbase construction activities.[136] More recently, Taiwan obtained timely forewarning of the PRC's intention to declare an air defense identification zone (ADIZ) over the East China Sea in November 2013. This allowed the ROC National Security Council to call an emergency meeting and deliberate in advance of the PRC declaration.[137]

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[130] See Guo Nairi, *The Unseen War in the Taiwan Strait;* see also Mark A. Stokes, *Revolutionizing Taiwan's Security: Leveraging C4ISR for traditional and non-traditional challenges* (Arlington, VA: Project 2049 Institute, February 2010), at http://www.project2049.net/documents/revolutionizing_taiwans_security_leveraging_c4isr_for_traditional_and_non_traditional_challenges.pdf.

[131] Russell Hsiao, "Critical Node: Taiwan's Cyber Defense and Chinese Cyber Espionage," *China Brief*, Vol. 13, No. 24, December 5, 2013, at http://www.jamestown.org/single/?tx_ttnews%5Bpointer%5D=56&tx_ttnews%5Btt_news%5D=41721&tx_ttnews%5BbackPid%5D=7&cHash=e45f03fd4c4c470bec9750b32400eb0d#.U20fE_ldVIc. See also Mark A. Stokes and L.C. Russell Hsiao, *Countering Chinese Cyber Espionage: Opportunities and Challenges for U.S. Interests* (Arlington, VA: Project 2049 Institute, October 2012), p. 11, at http://project2049.net/documents/countering_chinese_cyber_operations_stokes_hsiao.pdf.

[132] Author's interviews in Arlington (VA) with current and former officials, 2013-2014.

[133] Author's interviews with U.S. cyber security experts in Arlington (VA), 2013-2014.

[134] Wen Dong-Ping [聞東平], *The Intelligence War Now Underway* [正在進行的諜戰] (New York: Mirror Books, 2009); and multiple interviews in Arlington (VA) and Tokyo, 2013-2014.

[135] Author's interviews in Arlington (VA), Taipei, and Tokyo with current and former officials, 2013-2014.

[136] For example, see Mark Stokes, "Expansion of China's Ballistic Missile Infrastructure Opposite Taiwan," *AsiaEye Blog*, April 18, 2011, at http://blog.project2049.net/2011/04/expansion-of-chinas-ballistic-missile.html; J. Michael Cole, "NSB director confirms PRC deployment of 'new' missile unit in Guangdong Province, " *Taipei Times*, May 27, 2011, at http://www.taipeitimes.com/News/taiwan/archives/2011/05/27/2003504271; Russell Hsiao, "Taiwan Intelligence Chief Warns about the PLA's Growing Strategic Weapons Systems," *China Brief*, March 25, 2011, pp. 1-2; J. Michael Cole, "New PLA airforce base boosts capabilities," *Taipei Times*, May 28, 2012, at http://www.taipeitimes.com/News/taiwan/archives/2012/05/28/2003533924.

[137] Interview with senior ROC government official who participated in that meeting, Taipei, March 2014.

Fighters.[138] After its early-warning network, the most important aspect of Taiwan's air defense infrastructure is its fleet of tactical fighter aircraft. Fighters allow for long-distance patrols outside the range of air defense missile systems, and they provide commanders with a uniquely flexible platform for responding to adversary actions. Taiwan's defense policy community generally categorizes weapons systems according to their contributions to three major mission areas: air superiority, sea control, and counter-amphibious assault. Taiwan's fighters are unique in that they contribute to all three. Given the limited time and space available for responding to cross-Strait attacks, ROCAF must ensure its tactical fighters are able to maintain a sharp qualitative edge across the combat spectrum.

ROCAF now has 17 fighter squadrons and a total of approximately 400 combat capable aircraft. This includes 56 *Mirage* 2000-5s, 145 F-16A/B *Fighting Falcons*, 128 F-CK-1A/B *Ching Kuo* Indigenous Defense Fighters (IDFs), and 87 F-5E/F *Tiger* IIs (with some in reserve).[139] ROCAF fighters are tasked with conducting air patrols and reconnaissance missions in peacetime. During combat operations, Taiwan places a strong emphasis on using its tactical fighters in an anti-ship and ground attack role. To support these missions, Taiwan has introduced a number of new capabilities that allow its fighters to launch advanced missiles from outside the range of PLA air defense coverage.

Mirage 2000-5 Fighters: Based at Hsinchu Air Base in northern Taiwan, ROCAF's Mirage 2000-5 fighter jets are its heaviest and most capable air superiority asset. Taiwan acquired its Mirage 2000-5s from France in deliveries that ended in 1998, even before the French Air Force had upgraded its own Mirage fighters to a comparable standard. Tasked with defending the capital, Taipei, ROCAF's Mirage 2000-5 fighters have a top speed of Mach 2.2 and radars capable of tracking targets at a distance of 150 kilometers.[140] They can climb to an altitude of 40,000 feet in three minutes and shoot down at intruders, an attribute that gives them an advantage in responding to adversary surprise attacks. Taiwan's Mirage fighters are armed with 60 kilometer-ranged MICA missiles for beyond visual range (BVR) air-to-air combat, and they carry French "Magic" missiles for engagements out to 10 kilometers.[141] As an indication of their importance to Taiwan's national defense strategy, ROCAF's Mirage 2000-5 fighter squadrons typically get priority during wartime dispersal exercises to ensure they could survive PLA airbase strikes.

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[138] Unless otherwise noted, this section draws from Bernard D. Cole. *Taiwan's Security: History and prospects* (New York, NY: Routledge, 2006), pp. 106-110; and "Behind the Scenes: The Fortunate Secret of National Highway Take-Off and Landing Drills [透視內幕國道起降秘辛]," *National Geographic Channel*, October 9, 2011, accessible online at http://alert5.com/2011/12/10/youtube-inside-highway-runway/.

[139] *The Military Balance 2014* (London, UK: International Institute for Strategic Studies, 2014) p. 282.

[140] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技] (Taipei, Taiwan: NWCD Publishing, 2014), p.138. Note that this is the official textbook used by Taiwan's Ministry of National Defense and Ministry of Education for college level military education classes.

[141] Ibid., p. 140.

F-16 Fighters: Based at Hualien Air Base and Chiayi Air Base on Taiwan's east and west coasts, respectively, ROCAF's F-16s are its most capable multi-role fighters. Taiwan acquired its F-16 fighters from the U.S. in a 1992 sale, with deliveries arriving from 1997 to 1999. An all-weather fighter, ROCAF places a particular emphasis on operating F-16s at night, especially from Hualien Air Base where it conducts a "Top Gun" training course. Taiwan's F-16 fighters are capable of speeds over Mach 2. They are armed with AIM-120 BVR missiles that have a nominal range of 50 kilometers, and AIM-9 "Sidewinder" missiles with a range of 18 kilometers.[142] When not in an air combat role, Taiwan's F-16s are expected to conduct reconnaissance and strike missions. ROCAF is said to be currently the only service in the world to equip its F-16 fighters with AGM-84 "Harpoon" missiles. These can be programmed for both anti-ship and coastal attack operations.[143] Taiwan has also acquired the AGM-65 "Maverick" missile for anti-ship and coastal target suppression missions. To increase loiter time, ROCAF F-16 pilots are trained by their USAF counterparts for aerial refueling, and Taiwan is pursuing the acquisition of its own aerial refueling planes.[144]

Indigenous Defense Fighters: Based at CCK Air Base, Tainan Air Base, and Makung Air Base, ROCAF's IDF is Taiwan's mainstay rapid reaction fighter aircraft. Taiwan built these light-weight fighter jets indigenously with American technical assistance in the late 1980s. A twin-engine fighter, the IDF is capable of taking-off from alert station in 60 seconds. This rapid reaction time helps give ROCAF a much needed response force for intercepting air intruders. IDF fighters are armed with Taiwan's indigenous TIEN CHIEN-2 (TC-2), a "fire-and-forget" BVR air-to-air missile (AAM) equipped with active radar seekers and a range up to 100 kilometers.[145] For closer engagements, IDFs have high-speed TIEN CHIEN-1 (TC-1) "Sky Sword 1" AAMs with ranges of 18 kilometers.[146] Selected IDF squadrons are armed with Taiwan's WAN CHIEN standoff weapon. This 200-kilometer range precision guided weapon is designed for targeting PLAAF airbase runways and radar sites with submunitions capable of penetrating through 30 centimeters of reinforced concrete.[147]

Many ROCAF pilots and ground crew members undergo training at bases in the United States, and some train in France.[148] The rigor of Taiwan's pilot training, the high

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[142] Ibid., pp. 139-140.
[143] US-Taiwan Business Council, *The Balance of Air Power in the Taiwan Strait* (Arlington, VA: US-Taiwan Business Council, May 2010), p. 20.
[144] Of many sources, see Liu Wen-hsiao, "Taiwan's Chiashan Air Force Base: Combat Effectiveness Preservation and Tactics," *Ping-Ch'i Chan-shu T'u-chieh* (Illustrated Guide of Weapons and Tactics), July 2007.
[145] Ibid., p. 127.
[146] Ibid.
[147] The first unit to field the Wan Chien weapon is ROCAFs 443rd IDF C/D Tactical Fighter Wing at Tainan Air Base. See "Wan Chien Appears: Air Force 443rd Tactical Fighter Wing Development Program [萬劍亮相空軍 443 聯隊翔展專案], *Quanqiu Fangwei Zazhi* (Defence International), No. 354, February 2014, pp. 18-19. See also Wendell Minnick, "Taiwan Unveils First JSOW," *Defense News*, January 21, 2014, at http://www.defensenews.com/article/20140121/DEFREG03/301210016/Taiwan-Unveils-First-JSOW.
[148] For an excellent overview of Taiwan military training activities in the U.S., see Richard Halloran, "The US, Taiwan, and China's Long Shadow," *Air Force Magazine*, Vol. 95, No. 4, April 2012, at http://www.airforcemag.com/MagazineArchive/Pages/2012/April%202012/0412shadow.aspx. Note that

number of flying hours it maintains, and the advanced age of some of its antiquated F-5s has led to a number of pilot deaths. However, Taiwan's high-quality training regime gives ROCAF an advantage over the PLAAF. This is something that has become particularly important as PLAAF's numerical superiority continues to increase and a "fighter gap" emerges.[149] Indeed, Chinese military evaluations of Taiwan's air defense capabilities highlight the qualitative advantage that ROCAF enjoys in the air, and they demonstrate respect for ROCAF's ability to concentrate air power.

PLA analysts believe that ROCAF would have 92 fighters on emergency alert at the outset of hostilities, with an entire force of over 600 aircraft mobilized, including reserve force and armed training aircraft.[150] They assess that Taiwanese pilots are able to sortie two to three times on average per day, but are capable of organizing up to four daily sorties when needed.[151] PLA assessments note with concern that during night-time training drills, ROCAF has launched and coordinated over 20 aircraft on a single mission. They further note that Taiwan's pilots are trained to fight outnumbered, with each pair of ROCAF fighters capable of engaging four PLAAF fighters.[152]

Taiwan's F-16 pilots are trained in advanced F-16 tactics as part of the "Peace Phoenix" Program's 21st Fighter Squadron, see http://www.luke.af.mil/library/factsheets/factsheet_print.asp?fsID=5003&page=1, and http://www.luke.af.mil/library/biographies/bio.asp?id=16631. The squadron also trains Taiwan's F-16 maintenance crews, see http://www.luke.af.mil/library/factsheets/factsheet_print.asp?fsID=5004&page=1. ROCAF's relationship with the French Air Force, while important, appears to be less robust. See "Taiwanese Pilot Killed in Warplane Crash in France," *Defense News*, October 3, 2012, at http://www.defensenews.com/article/20121003/DEFREG01/310030008/Taiwanese-Pilot-Killed-Warplane-Crash-France.

149 US-Taiwan Business Council, *The Balance of Air Power in the Taiwan Strait* (Arlington, VA: US-Taiwan Business Council, May 2010), p. 23.

150 PLA General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," pp. 36-37.

151 Ibid., p. 37.

152 Ibid.

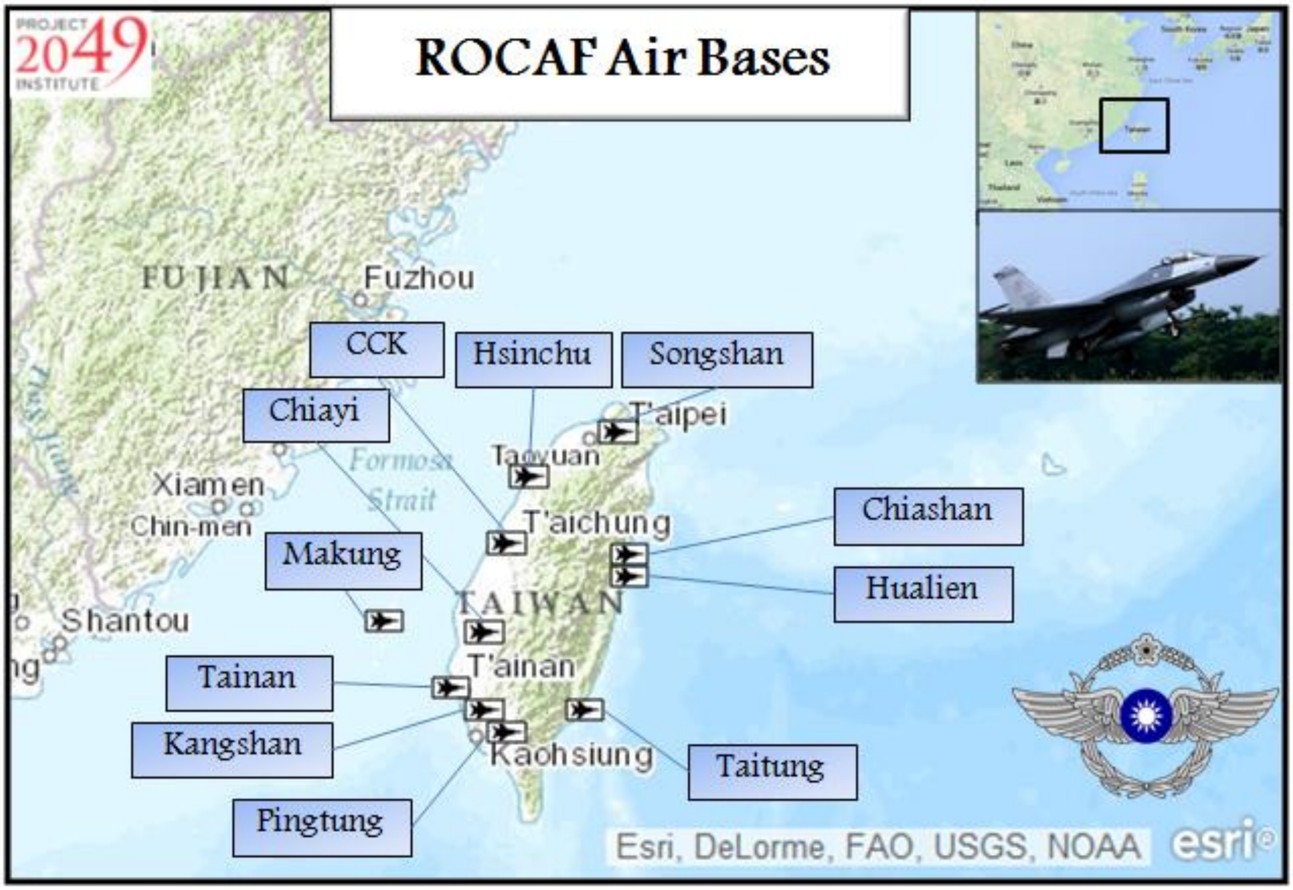

Figure 5: ROCAF Air Bases.

SAM Systems. To diminish the coercive utility of the PRC's build-up of offensive missiles, Taiwan is investing heavily in ballistic missile defense (BMD) systems. It is also improving its air defense systems for countering saturation attacks by cruise missiles, manned aircraft, and UAVs. Taiwan's armed forces currently have three Patriot Advanced Capability-3 (PAC-3) missile fire units deployed around the northern section of the island, and will soon acquire six more fire units for overlapping coverage of central and southern Taiwan. The ROC military will also acquire a tenth Patriot fire unit to be kept on training and reserve status.[153] All of these systems will be PAC-3 capable systems, with PAC-2 missiles integrated into firing units for defense against less sophisticated ballistic missiles and air targets.[154] According PLA analysts, Taiwan's Patriot missile fire units can each intercept 24 targets at a time, with an expected success rate of over 90 percent per missile interceptor.[155]

[153] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], p.143.
[154] Author's interviews in Arlington (VA) and Taipei, Taiwan with industry representative and government officials, April-June 2014.
[155] PLA General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," p. 37.

Taiwan has developed an indigenous air defense system that integrates the TIEN KUNG (TK) missile. Benefiting from U.S. and other foreign technical assistance, Taiwan's TK SAMs are comparable to Patriot systems in terms of capability. TK-1 missiles are fielded in both static and mobile variants, with a range of 100 kilometers. TK-2 missiles are deployed in hardened silo facilities with engagement ranges up to 200 kilometers.[156] Taiwan is currently looking to replace its older units with batteries of mobile TK-3 SAMs that are comparable to PAC-3s. Taiwan's TK fire units use advanced phased array radars that can track stealth fighters and other air breathing targets, as well as ballistic missiles.[157] Two TK fire units are deployed at Sanchih and Dushan, near Taipei and Taichung, respectively, and two batteries are located around Kaohsiung.[158] Two other TK fire units are deployed on the outer islands of Penghu and Tungyin, giving Taiwan the ability to engage front-line PLAAF fighters shortly after take-off from airbases in Fujian Province.[159]

Aside from BMD capable systems, Taiwan's air defenses include 16 HAWK missile batteries.[160] This aging air defense system was the predecessor to the Patriot, and would be most useful for defending against lower-flying targets. Taiwan plans to replace its HAWK missiles with new TK-3 systems by 2017.[161] For point defense, ROCAF fields the indigenous "Antelope" SAM system (vehicle mounted TC missiles), and the ROC Army (ROCA) fields 74 mobile "Avenger" SAM units (vehicle-mounted "Stinger" missiles), and two MIM-72/M48 "Chaparral" short-range air defense units (vehicle mounted AIM-9 "Sidewinder" missiles).[162] In addition, Taiwan has 63 AH-1W "Super Cobra" attack helicopters that can be armed with AIM-9 missiles for asymmetric air-to-air combat.[163] As a last line of defense, ROCA personnel are equipped with large numbers of shoulder-launched "Stinger" missiles.[164]

The Navy is an important element in Taiwan's air defense system. Taiwan has four KEELUNG class (formerly KIDD class) guided missile destroyers that are armed with the 150 kilometer ranged "Standard Missile-2" (SM-2) air defense missile. The radar

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[156] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], p.129.
[157] Ibid.; "Taiwan to spend $2.5 billion on anti-missile systems," *Defense News*, August 30, 2014, at http://www.defensenews.com/article/20140830/DEFREG03/308300024/Taiwan-spend-2-5-billion-anti-missile-systems?odyssey=mod_sectionstories; and Sophia Wu, "ROC Army Unveils Sky Bow Missile Base in Kaohsiung," *Central News Agency*, August 26, 1999, at http://fas.org/news/taiwan/1999/e-08-26-99-14.htm.
[158] Gao Zhiyang, "CSIST's Work and the Story of Tien Kung SAM [天弓前傳: 中山科學院的功績]," *Quanqiu Fangwei Zazhi* (Defence International), No. 297, May 2009, pp. 76-83; and Sophia Wu, "ROC Army Unveils Sky Bow Missile Base in Kaohsiung."
[159] Ibid. See also Sean O'Connor, "Taiwan's SAM Network."
[160] Wendell Minnick, "Taiwan Retires Hawk Missiles," *Defense News*, September 15, 2014, at http://www.defensenews.com/article/20140915/DEFREG03/309150036/Taiwan-Retires-Hawk-Missiles.
[161] Ibid.
[162] *The Military Balance 2014*, pp. 281-282.
[163] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], p.132.
[164] Ibid.

system on these destroyers can track up to 256 targets at a distance of 500 kilometers.[165] In addition, ROCN operates six KANG DING class (formerly LA FAYETTE class) guided missile frigates. These are to be outfitted with the HAI CHIEN-2 (a sea-based variant of the TC-2) missile by 2017 for improved air defense.[166] ROCN also has eight CHI YANG class (formerly KNOX class) guided missile frigates that are armed with SM-1 air defense missiles.[167] Looking ahead, Taiwan plans to develop and field indigenous ships with 3D phased-array radars and SM-3 missiles for a sea-based BMD capability.[168]

Beyond SAM systems, the ROC military fields some 400 anti-aircraft artillery pieces for point air defense. These include the M-42 self-propelled gun, and the thirty-five millimeter twin cannon gun (which have been upgraded and linked to "Skyguard" fire control radars).[169] Taiwan has several indigenously produced gun systems for defending its airbases against PLAAF air strikes and paratrooper assaults. These include the T82 20 millimeter gun with a two kilometer range and 1,200 shot per minute rate of fire.[170] This system has a helmet-mounted laser aiming system and night vision. In addition, Taiwan produces the T92 40 millimeter gun with a four kilometer range and rate of fire of 330 shots per minute. This gun has an electro-optical aim and control system, and it can be operated remotely.[171]

Taiwan's air and missile defense system links together all these assets to produce an integrated tri-service air defense network. This joint network is centered at the Hengshan National Command Center, a massive hardened tunnel facility in the northern suburbs of Taipei.[172] The "Strong Net" system integrates air force fighters and air defense command posts; ground force SAM bases; navy operations centers; and civil aviation airborne control centers.[173] Aside from providing Taiwan with a layered air defense shield at the high and medium altitudes, this system allows for a robust defense against low flying targets. In the event of conflict, PLA analysts expect that 80 percent of Taiwan's air defense systems would go to combat stations, and 20 percent would prepare for immediate launch, for an overall readiness rate of 95 percent.[174] This same

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[165] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], pp.134-135.
[166] Ibid. p. 135.
[167] Ibid.
[168] Wendell Minnick, "Taiwan Previews Major Naval Acquisition Plan," *Defense News*, September 20, 2014, at http://www.defensenews.com/article/20140920/DEFREG03/309200024/Taiwan-Previews-Major-Naval-Acquisition-Plan?odyssey=mod_sectionstories.
[169] *The Military Balance 2014*, p. 281.
[170] Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], p.128.
[171] Ibid.
[172] See Wendell Minnick, "Taiwan's Hidden Base will Safeguard Aircraft," *Defense News*, May 3, 2010, at http://minnickarticles.blogspot.com/2010/05/taiwans-hidden-base-will-safeguard.html; and Brian Hsu, "Air force shows off command centers," *Taipei Times*, September 8, 1999, at http://www.taipeitimes.com/News/local/archives/1999/09/08/0000001278.
[173] PLA General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]," p. 35.
[174] Ibid., p. 38.

report predicts that Taiwan's air defense guns could intercept up to 80 targets at a time, and notes that further improvements are being made to its systems.[175]

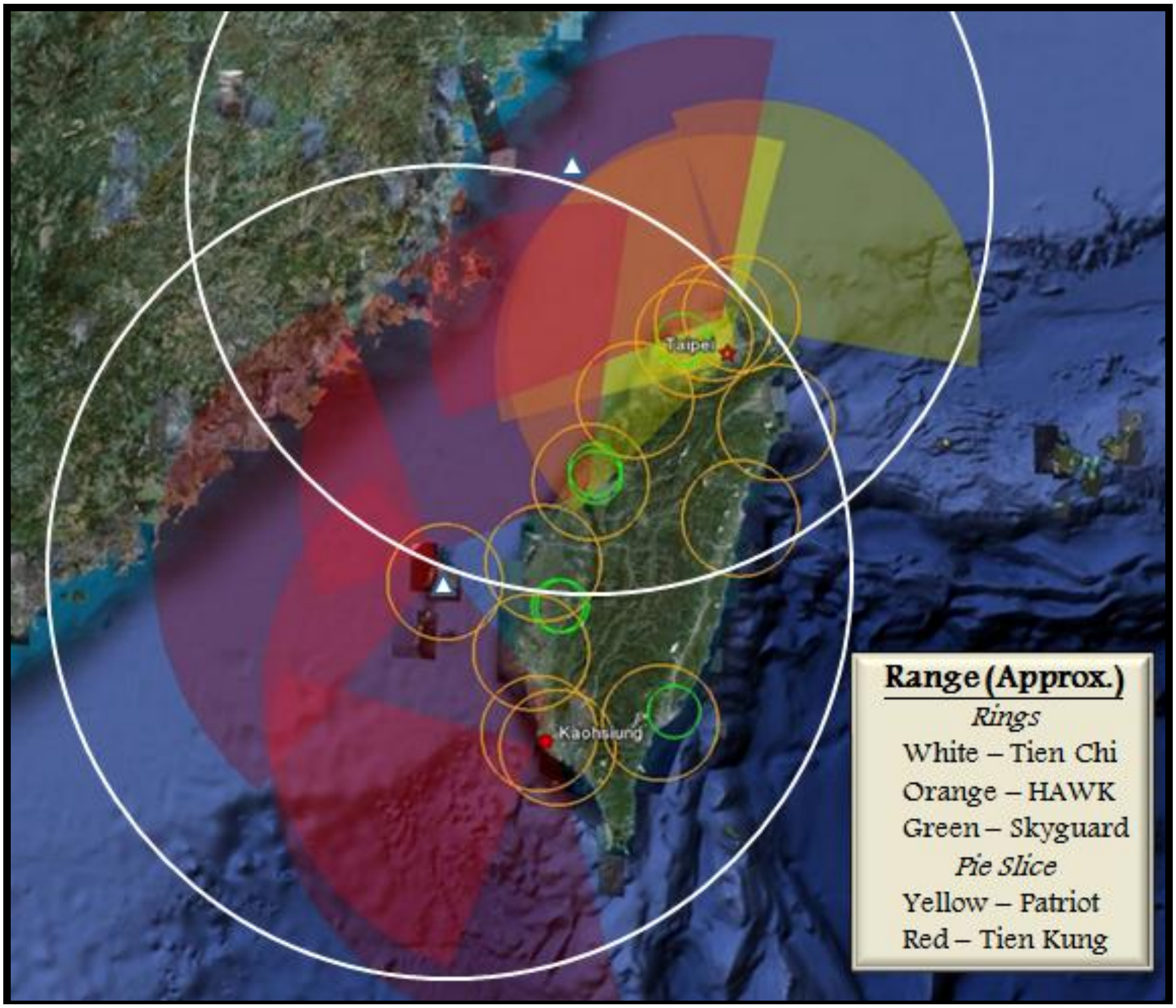

Figure 6: Taiwan's SAM and Tien Chi Missile Coverage (Source: IMINT & Analysis, 2009).[176]

[175] Ibid .
[176] It must be noted that this figure is incomplete. It does not include the long-range Tien Kung phased array radar on Tung-yin Island, or SAM radars on Kinmen and Wu Qiu-yu Islands. Further, it does not account for passive radars, Hawk radars that may have been upgraded to TK status, or long-range ROCN land- and ship-based radars. Nonetheless, it is the most complete figure that is publically available at the current time.

Counterstrike. Another long standing facet of Taiwan's air and missile defense network is its counterstrike capabilities. Recognizing that interdiction of single points of failure in the PLA reconnaissance-strike system could have outsized effects, the ROC military has maintained the capacity to "shoot the archer" in addition to the "arrow". Taiwan's military is believed to have deployed its first extended range strike capability in the late 1970s and 1980s. While uncertain, targets could include infrastructure supporting the PLA Joint Theater Command's primary command post, forward command post, and reserve command post, as well as Second Artillery corps-level command centers, associated communications centers, theater and sector air command posts, and other critical nodes. Success in achieving systemic effects through long range precision strike would be highly dependent on intelligence, and an assessment of escalation and political risks.

Taiwan's first generation CHING FENG missile is reportedly modeled upon the U.S. Lance missile. These were first deployed in 1981 in three regiments under the then-ROC Army Missile Command. Fielded on the front-line Kinmen and Matzu island groups, PLA intelligence believes the CHING FENG missile has a range of 130 kilometers, with some 150 missiles deployed on 50 launch vehicles before 2005.[177] Taiwan began deploying its second generation, 150-300 kilometers range TIEN CHI missiles in 1997 for the ability to hold mainland targets at risk from Taiwan's main island, the Penghu Islands, and Tungyin Island, where the PLA believes Taiwan had deployed 50 of these missiles in hardened silos by 2001.[178]

The ROC government has publically acknowledged that it has developed and deployed at least three squadrons of HSIUNG FENG-*IIE (*HF-2E) GLCMs. These are reportedly garrisoned in northern Taiwan and have ranges up to 1,000 kilometers.[179] While speculative, future HF-2E units could be deployed to Taiwan's offshore islands, if they haven't been already. The ROC military plans to develop air- and ship-launched variants of the HF-2E as well.[180] Taiwan has not released information about its current ballistic missile programs. However, there have been reports suggesting that Taiwan may have developed a small number of missiles with ranges up to 2,000 kilometers, and a larger number of missiles with ranges up to 1,000 kilometers.[181] Other reports suggest that

[177] Cai Jianhua, et al., "Research on Foreign (and Taiwan) Artillery Force Precision Guided Weapons Development [外(台)军炮兵精确制导武器发展研究]," *PLA 63961 Unit Intelligence Information Office*, January 2004. For an English language source, see "Ching Feng," *Missile Threat*, November 18, 2012, at http://missilethreat.com/missiles/ching-feng/; and "Taiwan: Missile Profile," *The Risk Report* (Wisconsin Project on Nuclear Arms Control), November-December 1998, at http://www.wisconsinproject.org/countries/taiwan/missiles.html.

[178] Cai Jianhua, et al., "Research on Foreign (and Taiwan) Artillery Force Precision Guided Weapons Development." For an English language source, see "Tien Chi," *Missile Threat*, November 18, 2012, at http://missilethreat.com/missiles/tien-chi/.

[179] Wendell Minnick, "Taiwan Working on New 'Cloud Peak' Missile," *Defense News*, January 18, 2013, at http://www.defensenews.com/article/20130118/DEFREG03/301180021/Taiwan-Working-New-8216-Cloud-Peak-8217-Missile; and Guo Wenliang, *National Defense Education: Defense Science and Technology* [全民國防教育國防科技], p.127.

[180] Ibid.

[181] James Dunnigan, "Taiwan's Secret Missiles," *Strategy Page*, May 14, 2011, at http://www.strategypage.com/dls/articles/Taiwans-Secret-Missiles-5-14-2011.asp. See also Gao Zhiyang,

Taiwan has developed an innovative, ramjet-powered surface-to-surface missile that does not travel along a traditional ballistic trajectory. This YUN FENG "Cloud Peak" program missile may have a range of up to 2,000 kilometers.[182]

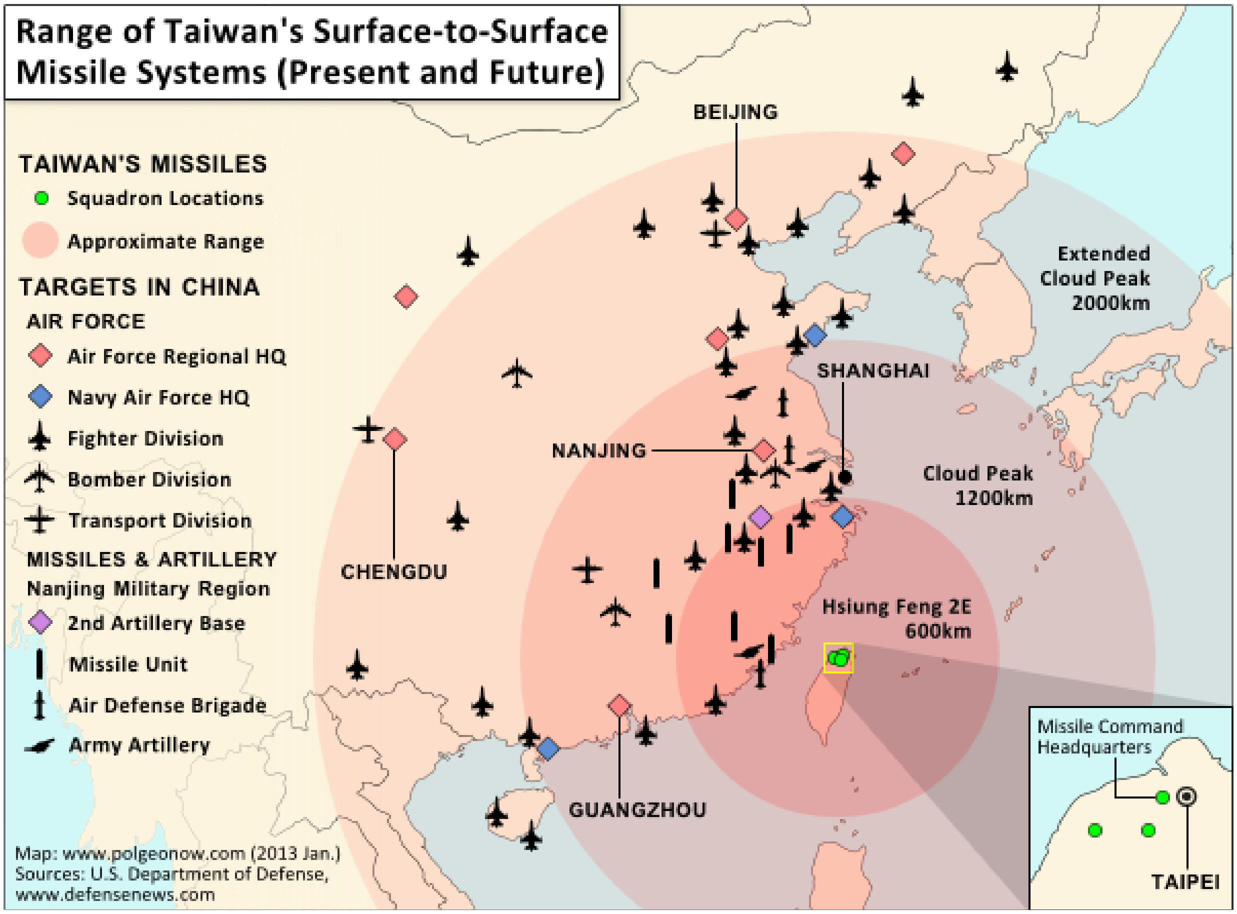

Figure 7: ROC Missile Range Estimates (Source: Michal Thim, Strategic Vision Vol. 2, Issue 7).

While ROC military officials have pledged that these capabilities would not be used in preemptive strikes against the Chinese mainland, some scholars have asserted that Taiwan would have a legitimate right to strike PLA military assets first if Taipei had I&W information showing an attack from the PRC was imminent.[183] In any event, the timing, scope, and intensity of all ROC counterattacks would depend heavily upon the

"Taiwan Small Satellite Launch Vehicle Development Plan [小型衛星發射載具研發計劃]," *Quanqiu Fangwei Zazhi* (Defence International), No. 331, March 2012, pp. 72-79.

182 Wendell Minnick, "Taiwan Working on New 'Cloud Peak' Missile," *Defense News*, January 18, 2013, at http://www.defensenews.com/article/20130118/DEFREG03/301180021/Taiwan-Working-New-8216-Cloud-Peak-8217-Missile.

183 Michael Thim, "Prickly Situation: Taiwan's missile program spurs debate on pre-emptive, porcupine strategies," *Strategic Vision*, Vol. 2, No. 7 (February 2013), p. 18, at http://www.mcsstw.org/web/SV/sv2013-0207.pdf.

political situation as well as Taiwan's own early-warning timeline, threat perceptions, available assets, and strategic objectives.

Chinese military analysts believe that the principal targets of Taiwan's interdiction operations would be the PLA's command and control centers, missile units, naval port facilities, airbases, radar sites, communications centers, and transportation nodes.[184] They note that Taiwan may develop penetrating warheads to destroy hardened targets such as underground command posts and concrete bunkers.[185] Other PLA analysts warn that Taiwan's ability to hold inland targets at risk with long range missiles will likely see a significant increase from 2015 to 2020.[186]

Large numbers of ballistic and cruise missiles could allow Taiwan to disrupt or destroy PLA strike units on the ground. They could also be utilized for attacking the PLA's array of long-range coastal radars, and its naval embarkation points.[187] Taiwan's WAN CHIEN missiles are designed to be launched from upgraded ROCAF IDF fighters. Taiwan's Harpoon missiles are deployed on F-16 fighters, aboard surface ships, and aboard two submarines.[188] ROCN fields both subsonic and supersonic HSIUNG FENG-2/3 (HF-2/3) missile variants for striking ships at sea and coastal targets. There has been a rapid build-up of these missiles since 2009.[189] HF-2/3 missiles are currently outfitted aboard surface ships, at numerous coastal bunker sites, and on mobile launchers.[190] In addition, they can be launched by IDF fighter aircraft. To provide for long-range target identification, Taiwan's ground and naval forces have been fielding UAV units.

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[184] Mo Xinhua, "Taiwan's Ballistic Missiles Target the Mainland [台湾弹道导弹瞄准大陆]," *World Outlook*, Vol. 10, No. 564 (May 2007), p. 19.

[185] Ibid. p. 17.

[186] Zhou Yi, et al., "Assessing Taiwan's Ballistic Missile and Cruise Missile Development [台湾弹道导弹与巡航导弹发展评析]," *Feihang Daodan* (Winged Missile Journal), No. 5, 2005, p. 29. For a more recent PLA analysis on Taiwan's strike targets, see Jiang Yanyu (ed.). *A Military History of Fifty Years in the Taiwan Area* 1949-2006 (台湾地区五十年军事史 1949-2006) [Beijing: Liberation Army Press, 2013], p. 228. Note that this is an authoritative text that was produced in partnership with the PLA General Staff Department and assistance from the Academy of Military Science's Taiwan Strait Military Research Center, the NDU Strategic Studies Department, and the State Council's Taiwan Affairs Office.

[187] Wendell Minnick, "Taiwan Working On New 'Cloud Peak' Missile," *Defense News*, January 18, 2013, at http://www.defensenews.com/print/article/20130118/DEFREG03/301180021/Taiwan-Working-New-8216-Cloud-Peak-8217-Missile.

[188] Wendell Minnick, "Taiwan's Sub-launched Harpoons Pose New Challenge to China's Invasion Plans," *Defense News*, January 6, 2014, at http://www.defensenews.com/article/20140106/DEFREG03/301060013/Taiwan-s-Sub-launched-Harpoons-Pose-New-Challenge-China-s-Invasion-Plans.

[189] For example, ROCN has recently fielded 30 FACG guided-missile patrol boats, each armed with four HF-2s. It has installed HF-2 or HF-3 missiles on most if not all of its 12 Jin Chiang patrol boats, which were previously unarmed or equipped with the HF-1. ROCN is also building up to 12 indigenous missile corvettes that will each carry eight HF-3s. The author is indebted to Craig Murray for this point.

[190] Wendell Minnick, "Taiwan Accidentally Reveals Missile," *Defense News*, January 28, 2008, at http://minnickarticles.blogspot.com/2009/09/taiwan-accidentally-reveals-missile.html. For example, ROCN has both fixed and mobile HF-2 missile units based on Hetien Mountain [贺田山] near Hualien. See "Land-based HF-2 Missile [陸基雄二飛彈]," *Quanqiu Fangwei Zazhi* (Defence International), No. 317, January 2011, pp. 18-21.

Taiwan began conducting initial research and development work on UAVs in the late 1960s.[191] More recently, two ROC military UAV types have emerged that elicit concern from PLA analysts. The TIEN SUN battlespace surveillance UAV system is designed for the 24/7 monitoring of surface targets. This mobile system is comprised of four aircraft, a control center, and other ground support vehicles. The PLA believes that each aircraft flies at up to 2,400 meters in altitude and can stay airborne for over five hours.[192] During training exercises held in 2012, TIEN SUN UAVs were used as mock targets to assist Taiwan's air and missile defense units train for countering PLA drone attacks.[193]

PLA sources report that Taiwan's more advanced CHUNG SHYANG UAV program includes aircraft equipped for ISR and electronic warfare missions over the Taiwan Strait. An early variant had a range of 500 kilometers and could stay airborne up to 10 hours.[194] The PLA believes that this UAV is endowed with stealth technologies and could be used for striking radar sites.[195] Taiwan officially stood-up its first UAV unit in 2012.[196] This consisted of an initial deployment of 32 CHUNG SHYANG-2 UAVs under the Army, with groups of eight UAVs deployed to four regional bases around Taiwan.[197]

Taiwan has been testing a stealthy anti-radiation UCAV for paralyzing the PLA's coastal early warning radars and SAM sites. Intended for deployment on road-mobile launch vehicles, the CHIEN SHYANG Program UCAV could be a highly effective means of responding to PLA strikes.[198] As an indication of intent, by early 2011 Taiwan's Ministry of National Defense (MND) had reportedly invested 100 million U.S. dollars into future long-range UAV technology development, and 34 million into an anti-radiation UAV technology program.[199] Taiwan's MND has also been investing in hypersonic vehicle capabilities, graphite bombs, and high energy Electromagnetic Pulse (EMP) weapon technologies.[200]

Working in concert with UAV units, ROCA's guided rockets and artillery could allow Taiwan's ground forces to saturate PLA facilities and ships with a large volume of low cost munitions. ROCA is thought to have over 300 heavy artillery pieces deployed on its

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[191] Gao Zhiyang, "Taiwan's First UAV Contact and Development [台灣初接觸無人機發展], *Quanqiu Fangwei Zazhi* (Defence International), No. 338, October 2012, pp. 68-75.

[192] Jiang Yanyu (ed.), p. 261.

[193] Wei Dongxu, "Taiwan Simulates PLA Employment of UAVs to Paralyze Taiwan Air Force [台模拟解放军动用无人机配合武直瘫痪台空军], *Global Times*, April 23, 2012, at http://mil.huanqiu.com/Taiwan/2012-04/2654923.html.

[194] Jiang Yanyu (ed.), p. 261.

[195] Ibid., p. 264.

[196] Ministry of Foreign Affairs, "About Taiwan: National Defense," *Info Taiwan*, March 17, 2014, at http://www.taiwan.gov.tw/ct.asp?xItem=126569&CtNode=3765&mp=1.

[197] Gao Zhiyang, "Taiwan's First UAV Contact and Development (Part Two) [台灣初接觸無人機發展], *Quanqiu Fangwei Zazhi* (Defence International), No. 339, November 2012, p.94.

[198] Ibid. pp. 98-99.

[199] *Defense and Security Report* (Arlington, VA: U.S.-Taiwan Business Council, Second Quarter 2011), p. 15.

[200] Ibid.

offshore islands within range of PRC territory.[201] The most advanced asset available is the RAY TING-2000 (RT-2000), an indigenous multiple launch rocket system (MLRS) that provides ground forces with the ability to strike targets 45 kilometers distant with cluster munitions. During the 2013 iteration of the annual HAN KUANG exercises, a RT-2000 company on the Penghu Islands took part in a live fire exercise to demonstrate the system's capacity for destroying an approaching amphibious fleet. The company's nine launchers fired 81 rockets armed with warheads that each dispersed 18,300 steel ball bearings over large area targets. In this case, the rockets saturated a target sea zone that measured 8,800 by 8,800 square meters.[202] Looking ahead, ROCA may develop longer-range MLRS capabilities for conducting counterstrike operations from the sanctuary of hardened facilities.

[201] Jiang Yanyu (ed.), p. 264. According to one senior ROCA officer, Taiwan has carefully surveyed and planned counterstrike operations for neutralizing PLA bases and supporting infrastructure within range with its artillery. Author's discussions in Taipei with ROC officer, June 2014.

[202] "The 29th Hankuang Exercise: Penghu Wude Joint Counter Landing Exercise [澎湖五德聯信聯合反登陸操演]," *Quanqiu Fangwei Zazhi* (Defence International), May 2013, p. 34.

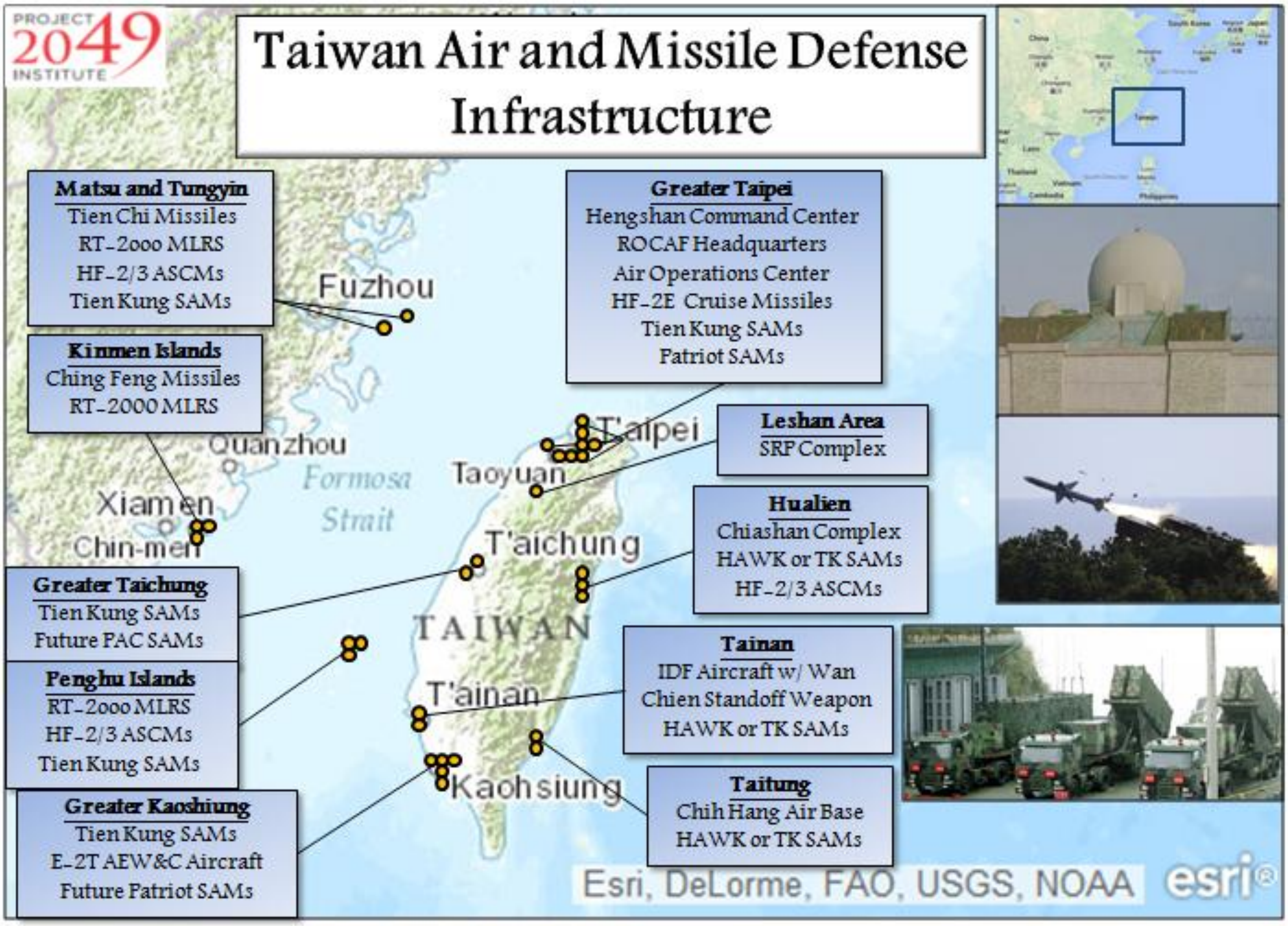

Figure 8: ROC Air and Missile Defense Infrastructure.[203]

[203] Note that this figure is incomplete. The location of many important ROC military assets is not publically available. Interestingly, a survey of internal PLA documents indicates that many ROC military unit locations may be unclear to them as well.

Special Operations Forces. Taiwan's SOF units have a long history of engaging in clandestine insertion operations into Mainland China for collecting intelligence and conducting sabotage. They play a key role in the defense of Taiwan's offshore islands along the Fujian coastline. The ROC Army Aviation and Special Force Command (ASFC) overseas some 9,500 personnel, including the 601, 602, 603 Aviation Brigades; the 101 Amphibious Reconnaissance Battalion; and the elite, 150 member Airborne Special Services Company. The ASFC includes a Special Forces Command that overseas six airborne battalions. Beyond the Army, the ROC Marine Corps (ROCMC) has a Special Services Company and amphibious reconnaissance "frogmen" units for special operations missions.[204] Like their Army counterparts, ROCMC frogmen are forward deployed on offshore islands for access into PRC territory.[205] Taiwan's Military Police Command and Coast Guard both have well-regarded special services companies as well.

To enhance their combat skills, Taiwan's special operations community reportedly sends select personnel to the U.S. for SEAL, Delta Force, Green Beret, Ranger, and Airborne training.[206] During a full-scale conflict, the ROC military would likely use its SOF units to strike a limited number of high-value targets on the PRC mainland that it deems are essential to PLA operations. Targets could include airfields, command posts, missile launchers, SAM sites, and port facilities. It is thought that Taiwan SOF units have already "prepared the battlefield" through the use of covert reconnaissance operations and the exploitation of agents that Taiwan may have in Fujian Province and elsewhere inside the PRC.[207]

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[204] Wendell Minnick, "Taiwan Modernizes, Streamlines Spec Ops," *Defense News*, December 20, 2011, at http://minnickarticles.blogspot.com/2010/12/taiwan-modernizes-streamlines-spec-ops.html.

[205] Author's interview with ROCMC officers in Taiwan, June 2014. See also "Republic of China Marine Corps [ROCMC]," *Global Security*, September 11, 2013, at http://www.globalsecurity.org/military/world/taiwan/rocmc.htm.

[206] Author's interviews with U.S. and Taiwan defense officials in Taipei, March and June 2014. See also Wendell Minnick, "Taiwan Updates Spec Ops Units," *Defense News*, May 19, 2008, at http://minnickarticles.blogspot.com/2009/10/taiwan-updates-spec-ops-units.html; and "US Army allows Taiwan students to mark uniforms," *The China Post*, July 24, 2011, at http://www.chinapost.com.tw/taiwan/foreign-affairs/2011/07/24/310873/US-Army.htm.

[207] Author's interview with Mr. Craig Murray, a former DoD analyst with significant Taiwan experience, May 2014, in Washington D.C.; and interview with a former ROC SOF unit commander that was based on an island near the PRC coast, June 2014.

Table 4. Taiwan Counterstrike Systems

Weapon	*Type*	*Range (km)*	*Number Deployed*	*Details*
Surface-to-Surface Missiles	Project Cloud Peak "Yunfeng"	1,000-2,000	Unknown, possibly up to 150 (2011 est.)	Family of advanced missile systems, likely includes those with non-ballistic trajectories
	TK-2B	Unknown	Unknown	Modified SAM
	Tienchi	300+	50 (2001 est.)	Deployed in hardened silos
	Qingfeng	130	150 missiles (2004 est.)	Deployed on mobile launchers
GLCMs, ASCMs, and Standoff Weapons	HF-2E	600-1,000	Three squadrons	Deployed on mobile launchers disguised as delivery trucks; CEP less than 5 meters
	HF-3	300-400	Unknown	Super-sonic; anti-ship and land attack variants; deployed in coastal bunker sites and on surface ships; road mobile variant in development
	HF-1/2	100	Unknown	Sub-sonic ship and air launched ASCM variants; also road mobile version
	Wan Chien	200	Unknown	Stealthy air-to-ground standoff weapon with runway penetrating submunitions
	Harpoon	Up to 280	32 (UGM-84L sub launched missiles), total numbers unknown	Advanced variants capable of conducting sophisticated maneuvers to penetrate defenses
UAVs	Chung Shyang I/II	500	Unknown	ISR and EW
	Tiansun I/II	Unknown	Unknown	ISR and EW
Rockets & Artillery	RT-2000	15, 30, 45 variants	Over 50 launchers, with up to 100 more expected	Can disperse 18,300 steel ball bearings with single rocket; also other warhead variants
	Heavy artillery (105-240mm)	Varies	Over 1,000 (300 forward deployed)	Ability to deliver low cost, high impact shells on close-in targets
Fighters	F-16, Mirage 2000, F-CK-1 IDF, F-5	Varies	Around 400	Capable of launching AIM-120, MICA, and TC-2 long-range air-to-air missiles; and variety of air-to-surface missiles

Sources: Defense News, PLA publications, ROC National Defense Report 2013, DoD 2013 China Military Report

Passive Defenses

The ROC military has invested heavily in passive defense measures to reduce the effects of PLA missiles and aircraft that are able to penetrate through its active defense networks. These measures help ensure that Taiwan can weather an enemy first strike with minimal force attrition and preserve sufficient combat power to achieve strategic objectives during follow-on operations. Passive defenses such as base hardening and resiliency provide Taiwan with a sustainable and cost-effective means of undercutting the utility of PLA precision strike capabilities. They increase the complexity of PLA operations and add uncertainty into the minds of adversary planners.

Taiwan's passive defenses work in tandem with its active defenses. The ROC military uses hardening and resiliency measures to protect its air and missile defense capabilities. Taiwan's radars, SAM launchers, and air defense guns are buried inside heavily fortified concrete bunkers or surrounded by earthen revetments. These defenses ensure survival against anything other than a statistically unlikely direct hit. As such, they have the effect of increasing the requirements placed upon PLA weapons manufacturers and operators, something that can raise unit costs, reduce range, and complicate maintenance. For example, a notional PLA missile that must have a CEP of five meters to hit a TIEN KUNG system's phased array radar bunker will be significantly heavier, more difficult to store and operate, and more prone to failure when compared to one that only requires a CEP of 75 meters to strike its target.

Taiwan's passive defense investments force the PLA to continually raise missile requirements, leading to prohibitively costly and sometimes fragile offensive weapons systems. Every additional line of code that must be inserted into a guidance system is a potential point of vulnerability, and every microprocessor added to a warhead increases the risk of electronic failure. This is especially relevant in the hot, humid environment that exists in the Taiwan Strait area. Moreover, intense electromagnetic warfare would define combat in this medium, and that would put the PLA at a disadvantage if its weapons were overly complex. However, assuming sufficient intelligence, time, money and technical resources, the PLA will eventually overcome the defensive measures employed by Taiwan at most fixed sites. For this reason, Taiwan is greatly improving the mobility of its units and investing in deception techniques.

Taiwan has begun developing and deploying a significant number of mobile C4ISR[208] and SAM units. Generally comprised of highway compatible vans, trailers, and launch vehicles, these units can conduct operations that are not tethered to military bases. This capability makes them extremely difficult to target even in an otherwise favorable reconnaissance environment. Yet many critical ROC military assets, especially fixed wing aircraft and ships, cannot operate without some form of airfield or port facility. Their survivability and effectiveness can nonetheless be improved with a combination of hardening, repair, and dispersal.

[208] C4ISR stands for command, control, communications, computers, intelligence, surveillance, and reconnaissance.

Taiwan has undertaken a remarkable series of engineering projects to construct underground tunnel complexes and hardened shelters for its ground forces, air force, and navy. Many of the most notable efforts to harden critical facilities in Taiwan and on its outer islands began in the wake of the shock that followed the U.S. decision to switch diplomatic recognition from the ROC to the PRC government in late 1978. Others are more recent. The following section will briefly overview the ROC military's efforts to make sure it can survive an enemy first strike and then rapidly generate combat power to counter follow-on PLA operations. Properly utilized, Taiwan's passive defense measures have qualitative force-multiplying effects that can help offset its quantitative disadvantages.

Offshore Island Hardening. Taiwan's national defense strategy has long called for keeping a cross-Strait war localized to its offshore islands and away from its densely populated west coast. Historical experience has shown the ROC government that fighting close to the Chinese Mainland from offshore island bastions is an economical way to keep the PRC tied down at a minimal cost in men and material. These islands draw the PLA's limited power projection capabilities away from assaults against Taiwan's home island, and "buy time" for the ROC military and society to mobilize for a long war of attrition. A number of critical island groups in the Taiwan Strait have been heavily fortified to support this strategy. Not only highly defendable, these islands are platforms from which the ROC military can launch counterstrikes against bases in the PRC and ships transiting the Strait.

Tungyin, a solid granite island less than 45 kilometers from the PLA's Fuzhou City, has a special role to play in Taiwan's military strategy. It was here in 1988 that Taiwan's 516th and 519th ROC Army engineering regiments began seven major military construction projects to bolster the island's defense. According to PLA writings, these projects aimed to build a series of hardened underground facilities that could withstand an all-out attack. When complete, the seven projects provided Tungyin with a TK-1 SAM site; a HSIUNG FENG anti-ship missile base; a TK-2 SAM site; a missile fast boat pen; a strategic tunnel network for cross-island transport; a buried fiber-optic communications grid; and an underground power plant.[209] PLA reports state that Tungyin's fortifications include a surface-to-surface missile base under the ROC Missile Command. The base's TIEN CHI missiles are thought to be deployed inside individual granite silos that are protected by SAM batteries and SOF units.[210] According to Mr. Craig Murray, a former U.S. Department of Defense analyst, Tungyin Island continues to serve as one of the ROC military's most lethal strategic outposts.[211]

In 1989, Taiwan began a project to further bury critical facilities on the already well-hardened Kinmen and Matzu island groups. This construction effort focused on digging

[209] Jiang Yanyu (ed.), p. 115. See also Wendell Minnick, "Taiwan Missile Base Identified Near China," *Defense News*, February 22, 2010, accessible online at http://minnickarticles.blogspot.com/2010/02/taiwan-missile-base-identified-near.html.
[210] See Cai Jianhua, et al.; Zhou Yi, et al.; and PLA General Staff Department 54 Research Institute, "Compilation of Air Defense Early Warning Information [防空预警资料汇编]. See also Wendell Minnick, "Taiwan Missile Base Identified Near China."
[211] Authors discussions with Mr. Craig Murray in Washington D.C., May 2014.

tunnel networks to house ROCA and ROCMC tanks, armored vehicles, rockets, equipment, and personnel deployed on these islands.[212] According to one first-person account, the project on Kinmen resulted in an effective underground transportation network.[213] In 1992, Taiwan's military engineers began a large scale project to harden facilities on the Penghu Islands. This project included the construction of a hardened command center for fighting vehicles; shelters for mobile air defense radars; bunkers for munitions storage; underground barracks facilities; and tactical gun emplacements.[214] Since that time, the Penghu Islands have added a TK-2/3 SAM battery capable of covering the Taiwan Strait (and parts of Fujian Province), an ASCM unit, guided rocket launchers, and long-range surface-to-surface missile launchers.

Home Island Defense. Beyond engineering efforts to harden offshore islands, Taiwan has constructed numerous tunnel facilities and stockpiled war-reserves on its main island. To ensure that its citizens and soldiers would be able to withstand blockades lasting several months or longer, Taiwan maintains a number of large tunnels and underground facilities for the secure storage of emergency food and fuel stocks. The ROC military stores the majority of its fuel in underground storage tanks, underground depots, and purpose-built caves. A portion of its fuel is allocated for storage in highly concealed facilities to further improve survivability.[215] These efforts are highlighted in a recent DoD report that succinctly states: "Taiwan has taken important steps to build its war reserve stocks."[216]

Further enhancing Taiwan's civil defense posture, Taiwan's two largest cities, Taipei and Kaohsiung, feature extensive metro systems that include miles of underground shopping malls and walking streets. Like most of the urban areas along its west coast, Taipei's central government district is notable for its large network of deeply buried parking garages. In wartime, these underground spaces could be rapidly converted for use as air raid shelters, hospitals, and military staging areas.[217]

To improve its survivability, the ROC military began a large scale effort to bury or otherwise harden all of its main war fighting units and facilities in the early 1990s. For example, Taiwan's 10th Army Corps in central Taiwan and 8th Army Corps in southern Taiwan reportedly completed the construction of underground facilities and bunkers for their armored brigades in 1992.[218] In northern Taiwan, ROC Army and Marine Corps units have emphasized rapid mobility and dispersal as well as hardening. To protect potentially vulnerable communications networks, ROCA constructed a network of fiber

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[212] Jiang Yanyu (ed.), p. 116.
[213] Author's interview on Kinmen Island with retired ROC soldier, May 2009.
[214] Jiang Yanyu (ed.), p. 116.
[215] Ibid., p. 155.
[216] *Military and Security Developments Involving the People's Republic of China 2014* (Arlington, VA: Office of the Secretary of Defense, 2014), p. 57.
[217] Notable underground civic facilities in Taipei include the walking streets that runs from Shuanglian Station to Zhongxiao Dunhua Station; the underground malls around Taipei Main Station; and the large parking garage networks that run underneath Shimin Boulevard, Da'an Forest Park, and Linsen Park. To keep up with the rising price of real estate, the trend in recent years has been to rapidly expand the number of underground commercial developments.
[218] Jiang Yanyu (ed.), p. 116.

optic cables and underground communications stations in the mid-to-late 1990s.[219] The resiliency of this communications network was reviewed by U.S. military assessment teams and further improved in the early 2000s.[220]

Airbase Hardening. Like the ground forces, ROCAF has been pursuing a large number of construction efforts to harden its bases against the PLA's growing precision strike capabilities. The first and most notable of these airbase construction projects began in the early 1980s. In consultation with U.S. military advisors, the ROC military selected a mountain area near the city of Hualien on Taiwan's east coast to serve as its national redoubt. After several years of surveying and planning work, construction began on Chiashan Air Base in 1985. During the first phase of construction, a five square kilometer area was cleared for the construction of an airfield and two tunnels large enough for securely operating over 200 fighter aircraft.[221] This airbase complex is notable for employing a long taxiway to connect it to Hualien Air Base so that fighters can rapidly move between the two airfields. In an emergency, the taxiway itself can be used as a runway.[222]

Completed in 1993, the first phase of the project cost around U.S. $1 billion. It included the installation of 10 electrically-operated blast-proof doors for aircraft entering or exiting the underground tunnel network. These thick doors can reportedly resist nuclear, biological, and chemical attack.[223] Chiashan Air Base includes underground facilities for storing large quantities of food, water, munitions, and fuel. The complex houses a command and control facility, a hospital, a power station, and aircraft repair shops. The second phase of the project was believed to have continued until at least 2010.[224] It included the construction of more hardened aircraft shelters, additional bunkers, and redundant internal lines of communications for moving aircraft between tunnels. The coastal area surrounding the Chiashan complex is believed by the PLA to include significant underground infrastructure for the secure housing of air defense radars, missile launch units, and even submarines.[225] This strategic area is guarded by two ROCA mechanized battalions, a military policy battalion, a ROCAF base guard group, and mountain warfare companies garrisoned in the Hsiulin mountain area.[226]

Taiwan has a second hollowed-out mountain base in Taitung on Taiwan's southeast coast. This tunnel complex is located at Chih Hang Air Base, and known colloquially as *Shihzishan* "Stone Mountain." It is thought to be somewhat smaller than Chiashan, but the base is still believed to be able to securely house 60-80 aircraft in its tunnel

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[219] Ibid. p. 148. See also Guo Nairi [郭乃日], *The Unseen War in the Taiwan Strait* [看不見的台海戰爭] (Xizhi, Taiwan: Gaoshou Publishing, 2005), p. 4.
[220] Author's interviews in Arlington (VA) with retired military officers and former officials, 2013.
[221] Jiang Yanyu (ed.), p. 84.
[222] Wendell Minnick, "Taiwan's Hidden Base Will Safeguard Aircraft," *Defense News*, May 3, 2010, at http://minnickarticles.blogspot.com/2010/05/taiwans-hidden-base-will-safeguard.html.
[223] See Liu Wen-hsiao, "Taiwan's Chiashan Air Force Base: Combat Effectiveness Preservation and Tactics," *Ping-Ch'i Chan-shu T'u-chieh* (Illustrated Guide of Weapons and Tactics), July 2007.
[224] Jiang Yanyu (ed.), p. 84.
[225] Ibid.
[226] See Liu Wen-hsiao, "Taiwan's Chiashan Air Force Base: Combat Effectiveness Preservation and Tactics."

networks.[227] Chih Hang Air Base is notable for the sheer number and complexity of its tunnel networks. According to one ROC officer who was based there, the facility is far larger and more spacious inside than it looks on satellite images.[228] The base may have hardened spaces large enough to park E-2T EW&C aircraft, and perhaps even wide bodied P-3C anti-submarine warfare (ASW) aircraft, although the latter seems improbable.[229]

Beyond its tunnel networks, ROCAF had built some 252 hardened aircraft shelters and 178 revetments at its airbases by 2008.[230] This number has continued to increase. For example, satellite imagery shows that Taitung's Chih Hang Air Base finished the construction of new shelters as recently as 2013, and more appear to be forthcoming.[231] Reportedly, there is a construction project underway at CCK Air Base in Taichung to build a large "super-hard" aircraft shelter that can surpass the ability of even tunnel complexes to protect against direct-hits by penetrating warheads.[232] In contrast to the aging U.S. and Japanese airbase shelters on Okinawa, Kyushu, and Honshu, which generally have walls that are only one or two feet thick, most Taiwan shelters appear to be protected by some six feet of concrete. Other new ROCAF shelters have thin walls made of advanced materials designed to force warhead detonation prior to impact.[233]

ROCAF Hardened Aircraft Shelters.
(Source: National Geographic)

[227] Matthew Hallex, "Taiwan Facing Up to the Airbase Survival Challenge," *AsiaEye Blog*, May 14, 2010, at http://blog.project2049.net/2010/05/taiwan-facing-up-to-airbase-survival.html. See also "Taitung Air Base/Chihhang Airbase," *Global Security*, undated, at http://www.globalsecurity.org/military/world/taiwan/taitung.htm.
[228] Author's interview with senior ROC officer in Washington, August 2014.
[229] This is because the E-2T has folding wings, while the larger P-3C does not.
[230] William Murray, "Revisiting Taiwan's Defense Strategy," *Naval War College Review*, Summer 2008, p. 22, at https://www.usnwc.edu/getattachment/ae650b06-a5e4-4b64-b4fd-2bcc8665c399/Revisiting-Taiwan-s-Defense-Strategy---William-S--.aspx.
[231] Note that in the history feature of Google Earth a large hardened aircraft shelter can be seen on June 27, 2013 at a location that was still being cleared on August 13, 2012. As of December 3, 2013, another site was still under construction nearby. See the area around these coordinates: 22.798779, 121.182818.
[232] See Zhou Yang, "Taiwan Simulates Fighter Attacks on Airfield: Military Official Says Can Repair 7 Bomb Craters in 90 Minutes [台模拟战机攻击机场 军官称 90 分钟可修 7 个弹坑]," *Global Times*, January 14, 2014, at http://mil.huanqiu.com/china/2014-01/4752220.html.
[233] See J. Michael Cole, "Visit to Hualien Air Force Base: F-16 Basics," *The Far-Eastern Sweet Potato*, January 25, 2013, at http://fareasternpotato.blogspot.com/2013/01/visit-to-hualien-air-force-base-f-16.html.

Warhead Resistant Hangar. (Source: J. Michael Cole)

Another aspect of airbase hardening is the creation of extra parking ramp space and taxiways to increase the lines of communication available to aircraft. Because much of the PLA's strategy would hinge upon cutting all the usable runway sections available to an airbase, Taiwan has expanded the number of taxiways and other operating spaces it could use as emergency runways during missile strikes. For example, CCK Air Base has seen the construction of new operating spaces that could be used for emergency take-offs.[234]

Connecting airbases to one another also adds to their defense and makes them more difficult to effectively neutralize. ROCAF has constructed long taxiways for this purpose at three sets of airfields: Chiashan Air Base and Hualien Air Base; Pingtung Air Base North and Pingtung Air Base South; and Taoyuan Air Base and Taoyuan International Airport. Unfortunately, the airbase at Taoyuan, which has dozens of hardened shelters and easy access to Taoyuan International Airport, is slated for closure and conversion into an economic development zone.[235] Taoyuan International Airport is constructing an alternative control tower and expanding its runways and parking ramps.[236] This perhaps could help offset some of the negative impacts that the Taoyuan Air Base closure will have upon ROCAF and ROCN operations in the capital area, but will probably not be sufficient.[237]

Airbase Resiliency. ROCAF employs rapid runway repair (RRR), dispersal, and deception to ensure it can recover and quickly generate air combat power after PLA attacks on its airfields. Strategic investments into advanced equipment and strict and frequent training have turned ROCAF into a global leader for airbase resiliency. Taiwan has some of the world's fastest, largest, and best-equipped dedicated runway repair teams, and it is the only country to regularly organize large-scale dispersal and highway strip air operations. Moreover, ROCAFs resiliency initiatives are often coordinated with

[234] Google Earth imagery reveals that this new taxiway section was constructed at the base around the 2011 timeframe.

[235] See Lo Tien-pin and Jake Chung, "Aircraft relocation spurs rebuke," *Taipei Times*, July 20, 2014, at http://www.taipeitimes.com/News/front/archives/2014/07/20/2003595511.

[236] See "Airport to get new control tower: CAA," *Taipei Times*, October 15, 2014, at http://www.taipeitimes.com/News/taiwan/archives/2013/10/15/2003574565; and Mavis Toh, "Taoyuan airport's runways to undergo upgrade," *Flightglobal*, September 2, 2013, at http://www.flightglobal.com/news/articles/taoyuan-airport39s-runways-to-undergo-upgrade-390073/.

[237] Wang Hsien-le, "Taoyuan Aerotropolis Project: Sacrificing National Defense [桃園空城國防大犧牲]," *Quanqiu Fangwei* Zazhi (Defence International), No. 320, April 2011, pp.8-11.

the other services and local government personnel, providing an opportunity to establish "jointness" across the force and enhance civil-military relations.

Recognizing that the PLA is targeting their runways, Taiwan's engineering teams maintain a strict training regime to keep runway repair skills sharp. A typical RRR squadron in Taiwan will be comprised of six component teams, for a total of 70 to 100 personnel that operate some 20 specialized armored vehicles.[238] Each component team conducts monthly training drills, and RRR squadrons conduct comprehensive exercises on a quarterly basis.[239] USAF RED HORSE[240] advisors regularly visit Taiwan, and ROCAF teams participate in the Silver Flag Exercises with their USAF counterparts on Okinawa and Guam.[241] More recently, American military training teams have been working with ROCAF and ROCA engineering units to improve their ability to rapidly clear unexploded ordinance from runways.[242]

CCK Air Base completed a practice runway section dedicated for the use of engineering teams in May 2008.[243] The RRR squadron at this base recently demonstrated the repair of seven large craters in 90 minutes.[244] While it generally takes four hours for ROCAF to repair an operational runway section, years of intense training have given some of Taiwan's RRR squadrons the ability to complete their mission in three hours.[245] In terms of capacity, ROCAF has acquired a large fleet of new armored repair vehicles and other advanced equipment from the United States including pre-formed and quick-set concrete, heavy earth moving equipment, and synthetic runway sections or "mats" that are designed to quickly bring an airfield's runways back into operation. These RRR kits have been deployed to all of Taiwan's airbases and additional kits are likely stored at regional logistics facilities.[246]

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[238] See "2014 Spring Festival Combat Patrol: Tough Tri-Service Readiness Drills Held [2014 春節戰鬥巡弋陸海空三軍精實戰力呈現], *Quanqiu Fangwei Zazhi* (Defence International), No. 354, February 2014, p. 35.
[239] Ibid., p. 36.
[240] RED HORSE is an acronym that stands for Rapid Engineering Deployable Heavy Operation Repair Squadron Engineer. See David W. Sommers, "554th RED HORSE "SEMPER DUCIMUS" for 47 years," *Pacific Air Forces News*, October 9, 2012, at http://www.pacaf.af.mil/news/story.asp?id=123321369.
[241] Author's interviews with U.S. defense official in Taipei, March and June 2014. See also Zachery Wilson, "Civil Engineer exercise open for business," *Stars and Stripes*, March 20, 2014, at http://guam.stripes.com/base-info/civil-engineer-exercise-open-business-guam; and Matthew Rochon, "Last Silver Flag on Kadena ends," *Kadena Air Base News*, May 29, 2013, at http://www.kadena.af.mil/news/story.asp?id=123350478.
[242] Author's interviews with U.S. defense officials in Taipei, March and June 2014.
[243] "2014 Spring Festival Combat Patrol: Tough Tri-Service Readiness Drills Held [2014 春節戰鬥巡弋陸海空三軍精實戰力呈現], *Quanqiu Fangwei Zazhi* (Defence International), No. 354, February 2014, p. 36.
[244] Zhou Yang, "Taiwan Simulates Fighter Attacks on Airfield: Military Official Says Can Repair 7 Bomb Craters in 90 Minutes [台模拟战机攻击机场 军官称 90 分钟可修 7 个弹坑]," *Global Times*, January 14, 2014, at http://mil.huanqiu.com/china/2014-01/4752220.html.
[245] Joseph Yeh, "Air Force drill displays rapid runway repair skill," *China Post*, January 14, 2014, at http://www.chinapost.com.tw/taiwan/national/national-news/2014/01/14/398317/Air-Force.htm.
[246] Author's interview with retired U.S. military officer involved in this security assistance program, Arlington (VA), April 2014.

A number of other efforts have been undertaken to ensure continuous and credible air operations. These include dispersal operations designed to rapidly spread or move key units, which are usually concentrated in limited areas, to reduce vulnerabilities. During Taiwan's annual HAN KUANG exercises, ROCAF regularly practices large-scale dispersal operations to certify its contingency plans. In recent years, the Mirage-2000 fighter wing at Hsinchu Air Base has demonstrated its ability to rapidly relocate *en masse* to Chiashan Air Base. To fill the temporary gap this creates in the air defense of Taipei, IDF squadrons based in the south of Taiwan have practiced relocating to Hsinchu Air Base to take the place of the departing Mirages. Meanwhile, F-16 fighter squadrons operating in Hualien have trained to conduct emergency landings at alternative east coast runways using arresting chutes and mobile arresting cable systems; and C-130 electronic warfare and transport aircraft have dispersed from Pingtung Air Base to a restricted area at Hualien Air Base that is prepared for them.[247]

Should conflict occur, ROCAF would disperse some of its fighter squadrons to civil airports and highway runway strips around Taiwan. In the 1970s, six sections of Taiwan's Sun Yat-sen No. 1 National Freeway were selected by the military to serve as back-up runways. These highway strips were all complete by 1979, and at least one flight test was conducted before the freeway opened.[248] Currently, four of these strips are still operational, along with a fifth strip on a provincial highway.[249] The first contemporary highway landing exercise occurred in 2004, when two Mirage fighters landed on the strip near Huatan. In 2007 and 2011, respectively, two larger-scale exercises were organized at other locations, and a fourth highway landing exercise occurred September 2014.[250]

Highway Runway Exercise 2011, Madou Strip
(Source: National Geographic)

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[247] Of many sources, see You Tailang, "Han Kuang Exercise: Back-Up Runway Landings Successful [漢光演習 副跑道降落圓滿達成], *Liberty Times*, April 18, 2012, at http://news.ltn.com.tw/news/local/paper/576866; and Fu S. Mei, "Operational Changes in Taiwan's Han Kuang Military Exercises 2008-2010," *China Brief*, May 27, 2010, at http://archive.today/CKBdm.

[248] The original six emergency runway sections on the San Yat-sen National Freeway (No. 1 National Freeway) were at Chungli, Huatan, Minsyong, Madou, Rende and Luchu. The Luchu section and the Chungli section were later deactivated due to maintenance issues. It is not clear when the Jiadong Provincial Highway strip south of Kaoshiung was added. For a detailed history of the emergency highway runway strips, see "Taiwan Defense Inspection: Fighter Evacuation and Freeway Emergency Runway Drill [空軍戰力保存與戰備道起降], *Quanqiu Fangwei Zazhi* (Defence International), No. 321, May 2011, p. 30. See also Sun Cheng, "Taiwan military successfully landed and took-off F-5 fighter on freeway 39 years ago [台军 39 年前完成公路战机起降 F-5 战机成功起降]," *Huanqiu Shibao* (Global Times), May 27, 2014, at http://mil.huanqiu.com/china/2014-05/5005675.html.

[249] Ibid.

[250] See Jason Pan, "Air force practices freeway landing," *Taipei Times*, September 17, 2014, at http://www.taipeitimes.com/News/front/archives/2014/09/17/2003599881/2; Chris Liao, "Freeway drill raises logistical issues," *Taipei Times*, May 20, 2007, at http://www.taipeitimes.com/News/editorials/archives/2007/05/20/2003361712/1; and "Section of

The 2011 highway runway exercise on the Madou section of the No. 1 Freeway, some 30 kilometers from Tainan Air Base, was notable for its scale and speed. ROCAF brought together some 150 vehicles and over 1,500 ground crew personnel for the exercise, as well as many support personnel from the other services and local government.[251] ROCAF ground crews readied the highway strip within four hours, and then three pairs of IDFs, Mirage-2000s, and F-16s landed in heavy fog. SOF helicopters provided site security and a cargo helicopter ferried in supplies. The six aircraft were refueled and armed with a combination of air-to-air and air-to-surface missiles; and they took-off again after 35 minutes on the ground. The entire exercise was finished and the highway opened to regular traffic again in less than six hours from the time it began.[252]

As a final note, ROCAF employs runway camouflage, concealment, and deception (CCD) to confuse the PLA's reconnaissance and operational planning communities. Examples include smoke screens that can interfere with laser targeting systems, and high fidelity decoys that mimic runway craters and debris to minimize the chance that a repaired runway will be targeted for follow-on strikes. Other false targets include fighter decoys that are parked on airbase ramps or in revetments. Looking ahead, Taiwan's Chung Shan Institute of Science and Technology (CSIST) is developing an advanced network of electronic warfare systems for jamming inbound PLA missiles. The project is referred to as the "Comprehensive Electronic Defense Combat Management Station Network."[253] ROCAF plans to have this network fielded by 2016.[254]

Left: Pilot takes off from Madou highway strip, 2011; Right: ROCAF Mirage Fighters on Rende highway strip, 2004 (Source: National Geographic).

freeway to be used for jet drill, military says," *Taipei Times*, February 25, 2014, at http://www.taipeitimes.com/News/taiwan/archives/2014/02/25/2003584311.

[251] For a detailed overview of the exercise see "Behind the Scenes: The Fortunate Secret of National Highway Take-Off and Landing Drills [透視內幕國道起降秘幸]," *National Geographic Channel*, October 9, 2011, accessible online at http://alert5.com/2011/12/10/youtube-inside-highway-runway/.

[252] Ibid.

[253] The Chinese term for this network is: 戰管陣地整體電子防護網.

[254] "Taiwan Spends 30 Billion to Build Missile Defense Net: Second Phase has Runway Repair and Camouflage to Trick Enemy [第二階段搶修跑道 偽裝欺敵 台砸三千億 建導彈防禦網], *Sing Tao Daily*, September 6, 2010, at http://news.singtao.ca/calgary/2010-09-06/taiwan1283761644d2712081.html; and Liu Wen-hsiao, "Taiwan's Chiashan Air Force Base: Combat Effectiveness Preservation and Tactics."

Table 5. Selected Taiwan Air Defense Events

Date	*Location*	*Details*
September 2014 (Hankuang 30 Exercises)	Minsyong Section of No. 1 National Freeway (Near Chiayi)	First test of emergency fighter operations at this location; previous drills at Madou and Rende sections of No. 1 Freeway near Tainan, and Huatan section near Changhua
January 2014	CCK Air Base in Taichung	Rapid runway repair drill results show recovery times down from four hours to three hours
April 2013 (Hankuang 29 Exercises)	Makung Air Base	Rapid runway repair drill
	Hsinchu Air Base	Rapid dispersal of Mirage-2000 wing, replaced by IDF fighters dispersed to Hsinchu from unidentified airbase; counter airborne and helicopter simulations conducted on base
	Chiashan Air Base	Receives and secures Mirage-2000 wing from Hsinchu
	Unidentified Air Base	Rapid dispersal of IDF fighters to Hsinchu Airbase
	Pingtung Air Base	Rapid dispersal of large aircraft to Hualien Airbase
	Hualien Air Base	Receives and secures large aircraft dispersed from Pingtung Air Base
January 2013	Hualien Air Base	Pilots practice short landings and maneuvers for operating on damaged runways; new hardened aircraft hangars revealed with designs for protecting against penetrating warheads
April 2012 (Hankuang 28 Exercises)	Chiashan Air Base; Emergency runway sites on east coast of Taiwan	F-16s operating from Chiashan Airbase practice emergency landing at alternative runways and deploy arresting chutes; officials announce Taiwan has established three main runways and three back-up runways on the east coast; runway specific camouflage to confuse PLA reconnaissance revealed
April 2011 (Hankuang 27 Exercises)	Madou Section of No. 1 National Freeway (Near Tainan)	Pairs of F-16, Mirage-2000, and IDF fighters practice arrested landings on freeway, then are reloaded by helicopter-delivered ordinance teams, and take-off again; a Super Cobra attack helicopter provides security
September 2010	Taipei	Government announces budget of 600 million NT for rapid runway repair equipment; invests in back-up runways and use of civil airports and camouflage; announces dispersed command and control system to avoid single points of failure
May 2010 (Hankuang 26 Exercises)	Hsinchu Air Base; Chiashan Air Base	Dispersal and redeployment of 45 Mirage fighters from Hsinchu Air Base to Chiashan Air Base; rapid runway repair and mobile aircraft arresting system drills at Chiashan; Taiwan announces that is has acquired over 300 rapid runway repair kits as well as dedicated heavy equipment and engineering teams that train regularly

Sources: U.S.-Taiwan Business Council's Taiwan Defense and Security Bulletins, Defence International, Defense News, China Brief, Kanwa Defense Review, Taipei Times, China Post, Liberty Times

CONTRASTING STRATEGIC APPROACHES

This section will briefly discuss the implications of the PLA's development of precision strike capabilities and Taiwan's efforts to counter them. In particular, it will build off the previous two sections to address the implications of the PLA's precision strike developments for Taiwan's future defense strategy.

First, it should be noted that the ability of the PLA's ballistic and cruise missile forces to penetrate Taiwan's air defenses depends heavily upon the operational effectiveness of Second Artillery and PLAAF units. Often ignored by PLA researchers is the reality that the capability of a missile system is not nearly as great as what might be indicated by calculations that assume optimal performance of every technical component. For example, in a system as complex as a ballistic missile brigade tasked with delivering runway penetrating warheads using supersonic and hypersonic vehicles in large multi-axis strikes, the overall performance would hinge upon how well the many individual elements of the system, both men and machines, interact.

It is important to recognize that the system can never be adequately tested. According to available sources, the Second Artillery Force has not tested more than 10 ballistic missiles simultaneously during exercises. Whether this was deemed sufficient by the PLA to certify wartime operational plans that could require hundreds or even thousands of coordinated missile launches is unknown.[255] Scripted and simulated environments are radically different from the real environment of war, in which systems and people have little time to adapt to the deadly situation. Also, PLA command and control platforms can fail even when the hardware and software components of the system are performing at their best.

Consequently, any assessment of the ultimate effectiveness of PLA missile strikes depends as much on ROC military capabilities and Second Artillery/PLAAF doctrine and operational plans (which we cannot evaluate) as on the technical functioning of missile hardware and software. Assuming a reasonably well coordinated series of missile salvos or "raids", Taiwan's air and missile defenses would have to be improbably effective to avoid saturation, exhaustion of magazines, and "leakage" of enemy missiles (the fraction that "leaks through" to hit targets). Yet if the PLA must be capable of destroying a significant proportion of a large number of separate, hardened and easily repaired ROCAF runway targets, an enhanced Taiwan air and missile defense system could be effective at denying PLAAF air superiority for an extended period of time. One sees little chance that the PLA's entire strike system could be effective enough to facilitate the taking of air superiority over the Taiwan Strait without risking a long and devastating campaign–especially in an environment where Taiwan is prepared to conduct counterstrikes against vulnerable PLA bases.

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[255] Author's interviews in Washington D.C. and Arlington VA, May and June 2014. A debate is apparently underway in multiple circles concerning how effective the PLA might be at coordinating large-scale strikes on Taiwan. PLA missile tests appear to include a considerable element of psychological warfare and aspects that indicate their intended purpose may be to intimidate foreign observers. For example, mock-ups of the ROC Presidential Office and key bridges in Taipei have reportedly been constructed in the PRC and then destroyed by PLA missiles within view of commercial imagery satellites.

In planning for precision strike operations against Taiwan, the PLA may have to accept that, whether or not it understands all the elements of ROCAF's air and missile defense or can evaluate their effectiveness even approximately; these defenses will continue to be dense and constantly upgraded. When viewed in this light, Taiwan's defensive position may be much better than generally recognized. Arguably, the probability of war in the Taiwan Strait is reduced not by the balance of forces, as measured by numbers and defense budgets, but rather by the quality of the balance. In an age of precision strike, a balance is stable if neither opponent, in striking first, gains the advantage of neutralizing the other side's ability to strike back. In spite of the considerable differences in national defense resources available, Taiwan can continue to keep the balance against the PLA stable if it invests wisely.

Here it is important to note that as a defensive or "status quo" state that is content with its existing territorial borders, and is only concerned with preserving its security and maintaining the sovereignty of its democratically elected government, Taiwan can advance its strategic objective by deterring the PRC's communist leadership from using force to settle political disputes. By convincing Beijing that the costs of conflict outweigh the benefits, Taipei advances its interests. Conversely, as a state that is inherently unsatisfied with its territorial bounds, the PRC must ultimately gain control over the ROC in order to achieve its strategic objective.[256] The Chinese Communist Party (CCP) leadership in Beijing must therefore court immeasurably greater risks and expend far more treasure in the attempt. Yet by attempting to decisively outmatch a well defended Taiwan, the CCP may defeat its own purposes and exhaust itself so much that it cannot resist the internal effects of overstrain. According to the British military historian B.H. Liddell Hart, self exhaustion in war has ended more regimes than any foreign aggressor.[257]

Going forward, Taiwan's challenge will be to find the type of strategy that meets its inherently limited security objectives in the most strength-conserving way possible. This will help to ensure its future as well as its present. To some it might seem that pure defense would be the most ideal strategy Taiwan could adapt, but static defense has historically proven to be dangerously fragile and often defeated.[258] Economy of force and deterrence are best balanced by the strategy that the ROC military currently employs, based on layered defenses and high mobility counterstrikes that carry the power of quick and proportional response to aggression. Moreover, it should be understood that as a state facing an existential threat, Taiwan will not likely be restrained from using any means available against the PRC to secure its existence.

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[256] B.H. Liddell Hart, *Strategy: Second Revised Edition* (New York: Meridian, 1991), p. 355.
[257] Ibid. See also the author's prepared statement before the U.S.-China Economic and Security Review Commission's "Hearing on China's Relations with Taiwan and North Korea," June 5, 2014, accessible online at http://www.uscc.gov/sites/default/files/Easton_USCC_Taiwan_Hearing_Statement_2014.pdf. Portions of this and the following section draw from this document.
[258] Ibid.

The following table outlines some of the key elements of the PRC approach to strategy at the national level of policy, and the countermeasures that the ROC employs against them.

Table 6. Contrasting PRC and ROC Strategies		
Tension Level	***Key Elements of PRC Strategic Approach***	***ROC's Strategic Countermeasures***
Low to Medium	Isolate Taiwan in the international community; erode the U.S.-Taiwan relationship through political warfare; invest in comprehensive military build-up	Maximize international space through pragmatic diplomacy; contribute to regional humanitarian assistance and disaster relief operation; train with U.S. military; purchase U.S. arms and pursue interoperability; engage in intelligence sharing
Medium to High	Coerce Taiwan and U.S. with large scale missile tests and other exercises; demonstrate resolve though statements and actions	Invest in advanced American and indigenous BMD systems; demonstrate the ability to fight under missile attack; appeal for U.S. and allied (Japanese) support
State of War	Engage in air and missile campaign to gain mastery of air and sea domains; conduct surprise maritime blockade operations and/or amphibious assaults	Survive first strike and respond with smaller but superior quality forces; conduct counterstrikes to deny PLA control of air and sea; raise political costs to Beijing to unacceptably high levels

The following table outlines some of the key elements of the PRC approach to Taiwan at the operational level of warfare, and the countermeasures that the ROC employs against them.

Table 7. Contrasting Operational Approaches of PLA and ROC Military

Key Elements of the PLA Operational Approach to Taiwan Air Blockade	***ROC Military's Operational Countermeasures***
Execute UAV, ballistic and cruise missile, and special operations attacks on Taiwan command and control centers and radar sites	Bury and disperse command and control centers; deploy back-up radars and mobile command posts
Conduct ballistic and cruise missile attacks on ROCAF airbase runways	Invest in BMD platforms, base hardening, and rapid runway repair; operate from commercial airports and highway strips
Execute an air campaign to gain mastery of the skies above the Taiwan Strait using fighter and bomber/strike aircraft	Strike front-line PLAAF airbases with air, surface, and subsurface missile attacks; insert commando teams to disrupt adversary air operations; improve short range SAM and AAA capabilities; stockpile munitions
Encircle Taiwan with aircraft carrier group(s) and other naval air forces	Saturate carriers with supersonic anti-ship missiles, increase number of submarines; mine approaches to PLA Navy port facilities
Operate from a large number of rear-area airfield sanctuaries	Develop and deploy advanced missiles and penetrating UAVs for deep strikes on rear-area targets

RECOMMENDATIONS

No democratic state playing the role Taiwan plays and aspires to play in the world should be in a position where it can be coerced by an authoritarian power. The United States assists the ROC in air and missile defense so that Taiwan is less vulnerable to the PRC which is within striking distance of its shores and cities. However, not all dangers to Taiwan's national security can be fully provided against. Taipei and Washington must concentrate on what is vital and prepare for the most effective and targeted military measures in the event of conflict.

As the PLA precision strike threat grows, the United States is debating the manner in which to best provide Taiwan with the arms and assistance necessary to defend its citizens. Increasingly, the people of Taiwan find it unendurable to imagine their nation falling into the orbit and influence of the PRC, and their existence becoming dependent upon Beijing's goodwill. It is to prevent this that every possible bulwark of missile defense is being constructed and maintained by Taiwan, and the development of air power given relative priority over other military considerations.

This final section offers some suggestions on how Taiwan, assisted by the United States, can better ensure its national defense in an age of precision strike. For simplicity, this section first addresses Taiwan's operational requirements as they relate to the subject of this study, and then discusses the importance of the U.S.-Taiwan military and security relationship. This section closes by offering some suggestions for American policy-makers working to improve Taiwan's ability to defend against PRC coercion.

Operational

The following suggestions center on exploiting or increasing the ROC military's advantages and limiting its vulnerabilities at the operational level of war. Given its centrality to the discussion at hand, particular focus is accorded to the air domain. However, all three of Taiwan's military services, as well as its Missile Command, Marines, and Military Police Command, would have critical roles to play in contributing to the following initiatives.

Mitigating the PLA Missile Threat to ROCAF Airbases. Taiwan should continue to advance its comprehensive effort to harden all its airbases. ROCAF should further improve its ability to operate from civil airports and highway strips in the event that its airbases were temporarily unavailable. This requires the stockpiling of petrol, oil, lubricants (POL), munitions, spare parts, and other items to enable sortie generation. This also requires coordination efforts with army aviation and SOF units, and with military police units, reserve units, and local law enforcement for site protection. ROCAF should demonstrate the ability to regularly disperse and operate from Taoyuan International Airport, Kaohsiung International Airport, and other civil airports. The ability to disperse to these airports would be particularly useful for ROCAF's fleets of large aircraft including its C-130 transport and electronic warfare aircraft, and its P-3C ASW aircraft. Taiwan could also consider the acquisition of the U.S. military's new airfield damage repair (ADR) capability for operating large aircraft on targeted runways, and ROCAF might benefit from advanced hardening technologies that have been developed for Andersen Air Force Base on Guam.

Passive defense measures such as improved hardening and resiliency are by themselves insufficient to ensure continual base operations in the face of large PLA missile inventories. Going forward, hardening and resiliency plans should only be considered in the context of an overall effort that incorporates active defenses such as advanced BMD and counterstrike capabilities. The centralized organizational nature inherent to the PLA offers single nodes of failure. Taiwan should continue to develop and deploy advanced missile capabilities for disrupting and whenever possible destroying key Second Artillery and PLAAF bases. Such capabilities are very useful for imposing costs on the PLA. For this reason, they must be deployed in sufficient numbers and in such a manner to guarantee that they could survive an enemy first strike. It must be clear to the PLA that its "archers" will not enjoy a sanctuary from which to engage in coordinated strikes against Taiwan's airbases once conflict begins.

Mitigating the PLA Air Threat to ROCAF Airbases. In addition to the measures discussed above, Taiwan should continue to invest in advanced C4ISR networks and platforms that allow its short-range SAM and air defense gun units to share a common operating picture and properly allocate targets. Even more importantly, the ROC military should increase its capabilities for attacking frontline PLAAF airbases. When compared to the ROCAF, the PLAAF is weak in runway repair and other base resiliency capabilities. Many PLAAF airbases are unhardened or insufficiently hardened. This critical weakness should be exploited. While PLAAF has a large number of back-up airstrips it could theoretically operate from after it lost its forward airbases, in practice the logistical burdens associated with dispersed operations would likely ground many fighter regiments that are known to suffer from serious shortcomings in operational maintenance and trained personnel.

By forcing the PLAAF to operate at long distances from the Taiwan Strait, the ROCAF could correct the numerical imbalance between the two sides even as its own ability to generate air combat power is reduced over time due to force attrition. Moreover, given the widespread inability of PLAAF fighter regiments to conduct nighttime strike operations, the ROC military should consider concentrating its counterattacks on PLAAF airbases when the greatest majority of adversary fighters would be parked in vulnerable revetments or hangars. It should be noted that many PLAAF airbases still do not feature advanced aircraft shelters. This leaves parked aircraft highly vulnerable to ballistic and cruise missiles, standoff weapons, UCAVs, and SOF attacks.

Correcting the PRC-ROC Imbalance in Long-Range Strike. Taiwan confronts a military adversary that relies very heavily on short- and medium-range ballistic missiles. Ballistic missiles are difficult and expensive to defend against. Taiwan should impose similar defense requirements and costs on the PLA by investing more in conventionally armed surface-to-surface missiles. The ROC military already has relatively large numbers of missile units for defending against its most important threats: PLA missiles, aircraft and ships. These counterstrike missiles are deployed on mobile launchers, aboard ships, on tactical fighters, and at land-based bunker sites. However, one notable weakness in Taiwan's counterstrike capabilities is its persistent shortfalls in inventories.

Although open source materials do not provide a good idea of how many missiles Taiwan has in its inventories, anecdotal evidence suggests that at least some missile units do not have sufficient numbers to reload their launchers after they expend their initial load-outs. Budget shortfalls and the political challenge of acquiring certain components from the U.S. will likely continue to make it difficult to address this shortfall. Nonetheless, Taiwan would be wise to continue its counterstrike missile buildup with all possible speed and on the largest scale which resources allow.

In terms of acquiring advanced strike aircraft, Taiwan should continue to pursue the acquisition of next generation stealth fighters with short take-off and landing capabilities like the F-35B. While both technological and political obstacles remain, it is possible that these can be eventually overcome. Should delays and cost overruns continue in the F-35 Joint Strike Fighter program, Taiwan could consider developing a future indigenous fighter with American, and possibly Japanese, technical assistance.

In the interim, Taiwan could consider improving its long-range strike capabilities by converting its retired fighter aircraft into unmanned decoys and UCAVs. Taiwan should continue to develop indigenous low-observable UAV systems capable of ISR, airborne electronic attack, and strike. If deployed in sufficient numbers on truck launch and recovery vehicles, armed UAVs could provide the ROC military with a highly survivable capability for degrading the PLA's integrated air defenses, ISR, and C2 networks. UAVs capable of airborne electronic attack would be particularly useful for increasing the effectiveness of standoff munitions and manned aircraft intended for strikes on targets in contested airspace.

U.S.-Taiwan Relations

The following suggestions relate to the importance of improving the U.S.-Taiwan military and security relationship. Given the political aims that will be at the core of any cross-Strait conflict, it is imperative that the ROC continues to advance its strategic partnership with the United States. The historical results of three major cross-Strait crises (and several minor ones) demonstrate the critical role that the U.S. has to play in deterring or limiting PRC aggression. The U.S. government should openly affirm that Taiwan has an important role to play in regional security. It is not in U.S. interests to see Taiwan slowly eclipsed by the PRC's emerging power. Moreover, the ROC's geostrategic location should compel Washington to do more to ensure Taiwan can maintain a strong BMD capability going into the future. The U.S. military cannot afford a gap in the emerging regional missile defense shield in the Western Pacific.

Increasing Taiwan's Role in the U.S. Military Rebalance to Asia. Taiwan has so far had an important, if low-key, role in the military component of the U.S. rebalance to Asia. Taiwan's critical geostrategic location has long made it a natural partner for the U.S. military. Further adding to its appeal, Taiwan is a liberal democracy that shares American values, such as the rule of law. Reflecting the importance of Taiwan to the rebalance, there has been an increase in the number of military exchanges between the U.S. and Taiwan. For example, over 2,000 U.S. Department of Defense visits to Taiwan occurred in 2013, over 500 more than the year prior. Significant numbers of U.S. military personnel are now conducting Chinese language and cultural immersion studies in Taiwan, while others are involved in programs to assist Taiwan further develop highly specialized military skills. Programs number in the dozens and include sniper training, rapid runway repair training, and unexploded ordinance disposal. The ROC military has also played an important role in supporting U.S.-led disaster relief and humanitarian assistance operations, for example by being the first responder to arrive after Typhoon Haiyan devastated parts of the Philippines in November 2013.

Going forward, the U.S. should continue to expand and deepen its military exchanges with Taiwan as part of the rebalance to Asia. Taiwan should be renewed as a hub for training U.S. government personnel. Given the unique expertise and historical experiences (as well as unparalleled access to information) that Taiwan's research centers offer, they should be leveraged by American military and intelligence officers studying the PRC. Even more importantly, the U.S. Navy should conduct port visits in Taiwan and DoD should invite Taiwan to the Rim of the Pacific Exercise and other maritime and air warfare events. The U.S. Pacific Command has operational plans for fighting alongside Taiwan's military. To assure that these plans could be fully executed, U.S. military leaders at all levels, up to and including the Commander-in-Chief, should engage with their Taiwan counterparts as a means of building greater trust and interoperability.

Advancing U.S.-Taiwan Security Cooperation. Improving people-to-people contacts in the government is vital for a healthy U.S.-Taiwan military and security relationship. In addition, there are many opportunities for cooperation between the U.S. and ROC defense industries that have yet to be realized. Taiwan is one of the world's leading consumers of American defense articles and services, in both the areas of foreign military sales and direct commercial sales. However, Taiwan's indigenous defense industry offers many innovative capabilities that could benefit the U.S. military. For example, Taiwan's HF-3 anti-ship missile is more capable than any comparable system fielded by the U.S. Navy in terms of range and speed.[259] Likewise, Taiwan's new air-launched WAN CHIEN standoff weapon could fill a gap in the U.S. Air Force inventory. Both systems are optimized for the unique threat environment that exists in the Western Pacific, and it is probable that both are more cost-effective than anything the U.S. defense industry could produce on short-notice.

[259] Author's interview with U.S. naval surface warfare officer in Yokosuka, Japan, November 2013.

The Pentagon now faces a number of pressing strategic requirements in the Pacific and a fiscally austere budget environment at home. The U.S. government should seek licensing agreements with Taiwan that would allow the flow of defense technology to go both ways. Instead of treating Taiwan like a wealthy customer (as the U.S. government often does), Washington should work to develop a truly cooperative relationship in the defense arena. The benefits for U.S. military capabilities and the defense savings could be immense. Missile technology is just one of many areas the U.S. could benefit from Taiwan's cutting-edge science and engineering talent.

Taiwan's Role in Air-Sea Battle. The Air-Sea Battle concept of operations is a classified Pentagon framework for coping with the rapid spread of anti-access/area-denial capabilities. Publically available information indicates that it seeks closer cooperation between the services in order to counter the potential for a devastating enemy attack on forward-deployed forces using sophisticated, but relatively inexpensive, long-range strike systems. Air-Sea Battle calls for closer cooperation between U.S. forces and coalition partners in forward deployed locations. Because of its strategic location and close military partnership with the U.S., Taiwan will naturally play a vital role in the concept in any future conflict with the PRC.

There are several indicators as to how successful the U.S.-Taiwan partnership is likely to be in shaping the future security environment in the Western Pacific. At the tactical level, the PLA's capabilities will add complexity to theater airbase and naval base defense and impose greater risks on aircraft and warships operating in contested areas. To meet these challenges, it will be important that American and Taiwanese investments are made into directed energy weapons for future air and missile defense. Greater investments are also required in electronic, cyber, and space warfare so that Chinese aggressors would face a layered defense that includes both kinetic and non-kinetic elements.

Taiwan's development of active *and* passive defenses for protecting against large-scale missile attacks should be emulated by other Air-Sea Battle partner nations that face similar threats, especially Japan. The remarkably high level of resiliency built into Taiwan's east coast airbases could make them ad hoc candidates for front-line American tactical fighter units engaged in wartime dispersal operations. Taiwan strike capabilities could also be tasked with neutralizing key PLA targets that threaten U.S. national assets. Going forward, the American, Japanese, and Taiwanese military planning communities should work closer together to make sure they could more seamlessly coordinate operations in the event that known contingencies occur.[260]

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[260] For more on this topic, see Mark Stokes and Russell Hsiao, "Why the U.S. Military Needs Taiwan," *The Diplomat*, April 13, 2012, at http://thediplomat.com/2012/04/why-u-s-military-needs-taiwan/.

Three U.S. Policy Recommendations

There are a number of ways in which U.S. decision-makers should consider improving Taiwan's ability to defend against Chinese precision strike capabilities. First, the administration should relax self-imposed limits on senior U.S. military officer visits to Taiwan. This would benefit the strategic positions of the U.S. in several important ways. It would allow senior officers with two star rank and above with significant joint experience to regularly visit Taiwan and get to know their counterparts and learn about the battlespace firsthand. Relying on information transmitted through distant intermediaries is detrimental for the Pacific Command's top admirals and generals, especially when the success or failure of a key operational plan is at stake. Keeping America's top military leaders blind and confused, and by extension the U.S. president who relies on their good judgments, would be a key adversary goal in a conflict. Moreover, without a closer "top-level" relationship, Taiwan's leaders could assume the worst in a conflict and take measures that would otherwise be unnecessary. As in any relationship, trust is critical, especially when life and death and the fate of nations are at stake.

Second, the U.S. government should promote bilateral defense industrial cooperation with Taiwan. Rather than spending finite resources on "re-inventing the wheel," the U.S. military could benefit from many of the defense technologies that Taiwan already possesses. Starting with working groups for innovation, technical assistance, and defense industrial cooperation, the two sides could move toward joint technology development programs similar to those in place with Japan.

Third, the U.S. executive branch should fully incorporate Taiwan into the rebalance to Asia and regional strategy. The constant pressure that Beijing puts on the White House, the State Department, and the Pentagon inevitably threatens to make any U.S. decision regarding Taiwan difficult and politicized. It is critical that the PRC is not allowed to shape U.S. policy behavior in ways that do not reflect American interests and values.

As a final note, the importance of Taiwan, due to its geostrategic position in the heart of East Asia and in the Western Pacific, far exceeds the size of its territory and population. Moreover, Taiwan is a democracy that plays a positive role in regional security. Taiwan's continued freedom of action hinges on its air strength. It must maintain the ability to contest PLA air superiority, not through competition in quantity, but through superior quality. The PRC would be highly reluctant to attempt a maritime blockade or amphibious invasion against Taiwan unless it could first establish air superiority. The ROC military's ability to deny the PLA control over the air domain significantly reduces the possibility of a cross-Strait conflict, and contributes to improved regional stability and supports U.S. security interests in Asia.

GLOSSARY OF TERMS

AAA – Anti-Aircraft Artillery, sometimes referred to as air defense guns
AAM – air-to-air missile
AB – Air Base
ADIZ – Air Defense Identification Zone
ADR – Airfield Damage Repair
AEW&C – Airborne Early Warning and Control
AOC – Air Operations Center
ASFC – Aviation and Special Forces Command
ASBM – Anti Ship Ballistic Missile
ASCM – Anti Ship Cruise Missile
ASW – Anti Submarine Warfare
BDA – Battle Damage Assessment
BMD – Ballistic Missile Defense
BVR – Beyond Visual Range
C2 – Command and Control
C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CCD – Camouflage, Concealment, and Deception
CCK – Ching Chuan Kang, airbase in Taichung
CCP – Chinese Communist Party
CEP – Circular Error Probable
CSIST – Chung Shan Institute of Science and Technology
CSS – NATO designator for Chinese missile
DF – *Dongfeng*, Chinese for "East Wind", designator given to Second Artillery ballistic missiles
DOD – Department of Defense
ECM – Electronic Countermeasures
EWR – Early Warning Radar
GAD – General Armament Department
GSD – General Staff Department
GLCM – Ground Launched Cruise Missile
HAS – Hardened Aircraft Shelter
HAWK – Homing All the Way Killer, U.S. air defense missile type
HF – *Hsiung Feng*, Chinese for "Brave Wind," name given to family of ROCN missiles
HUMINT – Human Intelligence
IDF – Indigenous Defense Fighter
ISR – Intelligence, Surveillance, and Reconnaissance
I&W – Indications and Warning
IRBM – Intermediate Range Ballistic Missile
LACM – Land Attack Cruise Missile
MLRS – Multiple Launch Rocket System
MND – Ministry of National Defense
MRBM – Medium Range Ballistic Missile
MRL – Multiple Rocket Launcher

NASIC – National Air and Space Intelligence Center
PAC – Patriot Advanced Capability
PLA – People's Liberation Army
PLAAF – People's Liberation Army Air Force
POL – Petroleum, Oil, and Lubricants
PRC – People's Republic of China
RED HORSE – Rapid Engineering Deployable Heavy Operation Repair Squadron Engineer
ROC – Republic of China
ROCA – Republic of China Army
ROCC – Regional Operations Control Centers
ROCMC – Republic of China Marine Corps
ROCN – Republic of China Navy
ROCAF – Republic of China Air Force
RRR – Rapid Runway Repair
SAF – Second Artillery Force
SAM – Surface to Air Missile
SIGINT –Signals Intelligence
SM – Standard Missile, naval air and missile defense interceptor
SOF – Special Operations Force
SRBM – Short Range Ballistic Missile
SRP – Surveillance Radar Program
TK – *Tien Kung*, Chinese for "Sky Bow," name given to family of ROC missiles
TRA – Taiwan Relations Act, U.S. Public Law 96-8
UAV – Unmanned Aerial Vehicle
UCAV – Unmanned Combat Aerial Vehicle
UHF – Ultra High Frequency
USAF – United States Air Force
USCC – U.S.-China Economic and Security Review Commission
USN – United States Navy

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