
# Evolving Aerospace Trends in the Asia-Pacific Region

***Implications for Stability in the Taiwan Strait and Beyond***

*Mark A. Stokes*

*Ian Easton*

PROJECT 2049 INSTITUTE

## 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. 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.

**www.project2049.net**


***Evolving Aerospace Trends in the Asia-Pacific Region***
***Mark A. Stokes & Ian Easton***
***The Project 2049 Institute***

*Date of publication: May 27, 2010*

Cover image: PLA medium range ballistic missiles
Source: Chinese internet

# Contents

# Introduction

Aerospace power is emerging as a key instrument of Chinese statecraft. Informed by universal air campaign theory and spurred by a global diffusion of technology, the People's Republic of China (PRC) is developing capabilities that could alter the strategic landscape well beyond the Asia-Pacific region. Aerospace power is unquestionably defining the future strategic environment in a region whose vast distances place a premium on speed and agility that defy the laws of gravity.

In this theater, aerospace power is the key to gaining strategic advantages by the application of military force via platforms operating in, or passing through, air and space. Control of the skies is a critical enabler for dominance over the earth's surface and is often a vital determinant of success or defeat in a conflict. Gaining and maintaining air superiority provides a political and military leadership with the operational freedom needed to coerce an opponent to make concessions in political disputes or gain a decisive edge on the surface.

The rise of China as a major economic, technological, military, and political player is changing the dynamics in the Asia-Pacific region and the world. Uncertainty over Chinese intentions is creating anxieties. As the Brookings Institution's Richard Bush notes, "a rising power poses a challenge to the prevailing international system and to the states that guard that system, because the new power's intentions are usually unclear."[1] Princeton University's Aaron Friedberg also explains "China's long-term strategic intentions are not only unknown, they are also, at this point, unknowable."[2] Against this backdrop of ambiguity and uncertainty about the future, China's aerospace developments merit further examination.

The People's Liberation Army (PLA) is rapidly advancing its capacity to apply aerospace power in order to defend against perceived threats to national sovereignty and territorial integrity. Constrained by a relatively underdeveloped aviation establishment, the PLA is investing in aerospace capabilities that may offset shortcomings in the face of a more technologically advanced adversary. Whoever dominates the skies over a given territory – be it Taiwan, disputed territories in northern India or Japan, or the South China Sea – has a decisive advantage on the surface.

Most significant is the expansion of, and growing reliance on, conventional ballistic and ground launched cruise missiles as the centerpiece of the PRC's political and military strategy. Large scale theater missile raids, combined with other enablers such as an electronic attack, directed against selected critical nodes within an opponent's command and control structure or air defense system can enable conventional air operations to be carried out at reduced risk and cost.

Barring the fielding of effective countermeasures, Chinese conventional theater missiles, specifically short and medium range ballistic and extended range land attack cruise missiles, may give the PLA a

decisive advantage in future conflicts around China's periphery. Ballistic and ground launched, land attack cruise missiles (LACMs) are an attractive means of delivering lethal payloads due to the inherent difficulties in defending against them. Ballistic missiles themselves have a strong coercive effect as potential adversaries around the PRC periphery have limited defensive countermeasures.

The PRC is also focused on developing the means to deny or complicate the ability of the United States to intervene in a regional crisis. Authoritative Chinese writings indicate research into, and development of, increasingly accurate and longer range conventional strategic strike systems that could be launched from Chinese territory against land and sea-based targets throughout the Asia-Pacific region in a crisis situation.

Extended range conventional precision strike assets could be used to suppress U.S. operations from forward bases in Japan, aircraft battle groups operating in the Western Pacific, and perhaps over the next five to 10 years from U.S. bases on Guam. Development and eventual deployment of an anti-ship ballistic missile (ASBM) is an example of this emerging capability. China's research and development (R&D) community is also expanding the nation's capacity for regional maritime surveillance. Most noteworthy is the development of slow moving flight vehicles that operate in near space – the domain above where conventional aircraft fly yet below orbiting satellites.

Beijing's theater missile-centric strategy presents challenges that transcend the operational realm. Beijing's large infrastructure of short range ballistic missiles (SRBMs) opposite Taiwan fosters mistrust and discourages meaningful political dialogue that could lead toward a resolution of differences in a manner acceptable to people on Taiwan and the international community.

Beyond Taiwan, the conventional theater missile[3] build-up has the potential to create strategic competitions that increase the risks of conflict in the future. The PRC's growing capacity to exercise its aerospace power around its periphery provides an incentive for neighbors to shore up defenses, as well as develop similar capabilities. The most effective and efficient means of defending against theater missiles is neutralizing the missile infrastructure on the ground. In the absence of a common framework governing the horizontal and vertical proliferation of ballistic and ground-launched cruise missiles, countries throughout the region, including the United States and India, are by necessity increasing investment into long range precision strike systems in order to maintain a conventional deterrent and ensure effective defense should deterrence fail.

China's successes in designing, developing, and producing the world's largest and most sophisticated arsenal of medium and intermediate range ballistic missiles creates a demand for similar capabilities around the world. In other words, the PLA's conventional theater missile-centric strategy potentially weakens international efforts to curb the proliferation of the means of delivery for weapons of mass destruction.

Ballistic and ground-launched cruise missiles have long been of sufficient concern to warrant international agreements to limit their horizontal and vertical proliferation. The 1987 Intermediate

Range Nuclear Forces (INF) Treaty led to elimination of U.S. and former Soviet land-based ballistic and cruise missiles with ranges of between 500 and 5,500 kilometers. In 2007, however, senior Russian officials announced a possible withdrawal from the INF Treaty unless it was implemented on a global basis. Opinion leaders in Moscow cited particular concern over the expansion of neighboring theater missile forces. The Missile Technology Control Regime (MTCR) and Hague Code of Conduct against Ballistic Missile Proliferation (HCOC) have both intended to stem the proliferation of unmanned delivery systems capable of delivering weapons of mass destruction. More recently, calls have been made to strengthen international regimes to control the proliferation of extended range LACMs.

This monograph addresses trends in PRC force modernization, strategy, and doctrine that are intended to exploit weaknesses in regional air defenses, including a growing ability to maintain persistent surveillance out to a range of 3,000 kilometers. Included is a detailed overview of China's expanding short and medium range ballistic missile and ground launched cruise missile infrastructure. The subsequent section outlines trends in conventional air force, air and missile defense, and long range precision strike modernization in Taiwan, Japan, India, and the United States. The final section addresses options for countering the coercive utility of evolving PRC aerospace power, including cooperative threat reduction initiatives.

# Aerospace Campaign Theory

Unimpeded access to skies over a region is a significant demonstration of power. As a key architect of modern U.S. air doctrine, retired Colonel John Warden once observed, "no country has won a war in the face of enemy air superiority, no major offensive has succeeded against an opponent who controlled the air, and no defense has sustained itself against an enemy who had air superiority." The Joint Chiefs of Staff (JCS) defines air superiority as "that degree of dominance 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."[4] As Warden observed, "to be superior in the air, to have air superiority, means having sufficient control of the air to make air attacks on the enemy without serious opposition and, on the other hand, to be free from the danger of serious enemy air incursions."[5]

Success in a sea control campaign, an amphibious invasion, a ground campaign, or a coercive air campaign depends upon air superiority, as it significantly reduces the risk of surface operations. In a conflict, the side that first wins air superiority will gain an overwhelming advantage.

Attainment of air superiority requires neutralizing or suppressing assets that can interfere with air operations, including fighters, ground-based air defenses, sensors such as radar systems, jammers, and various supporting infrastructure. Like all other systems, air defense has points of failure that could have system-wide effects if neutralized. For example, since air defense systems rely on centralized control, the loss of a national, theater, or tactical-level air defense command center could affect the operations of all assets under its control. Similarly, the loss of a control station or radar could affect the operations of surface-to-air missile battalions that control multiple launch units. For countering fighters and other long range precision strike assets, history has shown that, if operational surprise can be achieved, targeting runways, logistical support, aircrews, and aircraft on the ground is more cost effective than fighting air battles.[6]

A strategy for attaining air superiority can be operationally offensive, defensive, or a combination of both. However, a defensively configured force risks relinquishing initiative to the attacker and requires greater resources than offensively configured force structure. In addition, as Warden notes, a defensive-oriented force by itself "can lead at best to a draw, never to a positive result."[7] On the other hand, an operationally offensive approach can maintain the initiative, keep the fight on enemy territory, extract maximum leverage from limited air assets, and increase stress on the defender. However, if the defender has the advantage, an aggressor would likely conclude that the costs of an offensive campaign may outweigh the benefits.

Aerospace power can serve political as well as military objectives. Coercive aerospace power is the integrated application of information operations and weapon systems, through the medium of air,

against strategic and operational-level targets to influence an adversary to act in a manner that it may not otherwise. Therefore, strikes are not only mounted or threatened against key infrastructure and installations, but are also intended to change the target entity's policy. Hence, the effectiveness of a coercive air campaign is measured by strategic outcomes, notably attainment of political goals, rather than on tactical effectiveness (such as how well bombs, missiles, and electronic attack affects targets).

# Chinese Aerospace Campaign Theory

Influenced by U.S. campaign theory, aerospace power is emerging as a key instrument of PRC statecraft. Like most defense establishments, the PLA characterizes its modernization efforts as defensive in nature. To this end, aerospace power is viewed as a vital element of territorial air defense with offensive air operations as a key capability. As the PRC's 2008 Defense White Paper explains:

> *China pursues a national defense policy which is purely defensive in nature. China places the protection of national sovereignty, security, territorial integrity, safeguarding of the interests of national development, and the interests of the Chinese people above all else.*[8]

Over the years, the PLA has made significant advances in developing a force capable of applying aerospace power in a joint environment.[9] PLA analysts view aerospace campaigns as an integral component of "firepower warfare," which involves the coordinated use of PLA Air Force (PLAAF) strike aviation assets, Second Artillery conventional theater missiles, and information warfare. Although China's military leadership appears to be developing a range of options for all levels of warfare, the PLA is most disposed toward a denial strategy that emphasizes operational paralysis as a means of defense or duress to compel an adversary to heed Beijing's will.

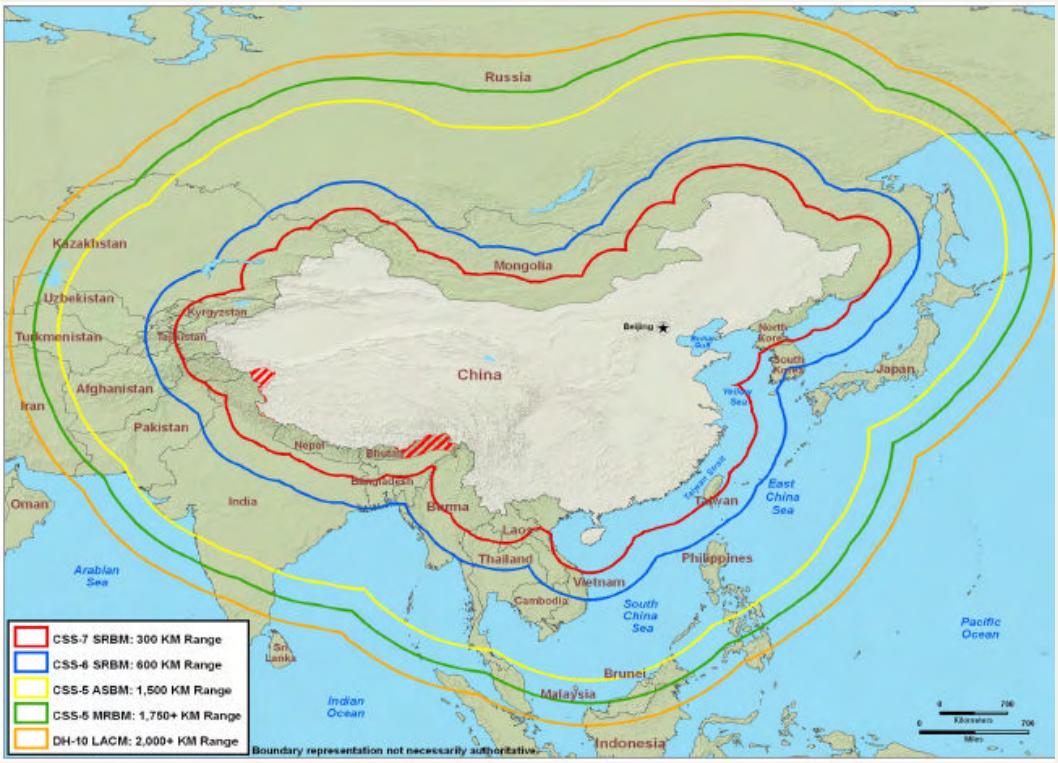
A coercive campaign would require a highly centralized operational command and control system that is closely linked to the political leadership. In this scenario, a Joint Theater Command would be responsible for operational-level command and control. With Theater Command's primary command post as the critical node for directing operations, other supporting facilities would include centers for communications, firepower coordination, intelligence information, electronic countermeasures command, and weather. Among these, the firepower coordination center is critical for guiding the air and theater missile campaign against key targets in order to achieve strategic and theater objectives. PLAAF, Second Artillery, special operations, and ground force representatives man cells and liaise with their respective component-level operational command centers.[10]

Since as early as 2004, a guiding PLA objective for developing its armed forces is "informatization." This principle stresses the centrality of information technology in weapon systems and their operation. Investment priorities include increasingly accurate and lethal theater ballistic and LACMs; development and acquisition of increasingly sophisticated multi-role fighters; and development of stand-off and escort jammers as well as other electronic warfare assets. At the same time, Beijing is investing in advanced command, control, communications, and intelligence systems while placing greater emphasis on training, particularly through the use of simulators.

# Chinese Force Modernization

Today, the PLA leadership depends upon its ballistic and land attack cruise missile force – the Second Artillery – to deter potential adversaries, and defend against perceived threats to national sovereignty and territorial integrity. Increasingly accurate conventional ballistic missiles and ground launched cruise missiles (GLCMs) are the optimal means for suppressing enemy air defense and creating a more permissive environment for subsequent conventional air operations due to their relative immunity to defense systems. In a conflict, they can be supported by electronic attack assets which reduce early warning and confuse enemy commanders. In addition, space-based, airborne, and ground-based sensors can facilitate command and control, and provide crucial strategic intelligence, theater awareness, targeting, and battle damage assessment information.

The joint application of aerospace forces creates a synergy that could have significant military and political effects. Looking beyond traditional ballistic and land attack cruise missiles, China currently views the realm between the atmosphere and space as a new area of global competition. This has compelled its research and development community to conduct feasibility studies into a new generation of flight vehicles and sensor systems.




Regional conventional missiles. Source: DOD China Military Power Report, 2009.

## The Centerpiece of China's Coercive Aerospace Power: Conventional Ballistic and Land Attack Cruise Missiles

The PRC's growing arsenal of increasingly accurate and lethal conventional ballistic and land attack cruise missiles has rapidly emerged as a cornerstone of PLA warfighting capability.

Since the official establishment of the PLA's first SRBM brigade in 1993, ballistic missiles have been a primary instrument of psychological and political intimidation, but also potentially devastating tools of military utility. As witnessed in 1995, the PLA launched four missiles off the coast of Taiwan as a warning to the island's politicians. Six months later, the *New York Times* reported explicit Chinese threats to conduct follow-on ballistic missile exercise strikes in order to deter perceived moves toward *de jure* independence by then-KMT President Lee Teng-hui and to send a signal of Chinese displeasure to the international community. While many in Beijing appear convinced that the missiles were politically effective, others acknowledged that the exercises sparked worldwide anti-China sentiment, strengthened U.S. alliances in the region, re-invigorated the U.S.-Taiwan defense relationship, and hardened U.S. resolve to intervene in any future use of force against Taiwan.[11]

Over the last two decades, the Second Artillery's conventional ballistic and land attack cruise missile force - a form of aerospace power that will be critical for achievement of information dominance and air superiority in the opening phase of a conflict - has significantly expanded. Reporting directly to the Central Military Commission, Second Artillery headquarters oversees one central nuclear warhead storage base and six missile bases that operate throughout the vast expanse of China:

- Headquartered in Shenyang, 51 Base consists of five brigades extended across five provinces in north and northeastern China.
- From Huangshan city in Anhui, the 52 Base oversees five SRBM brigades and as many as three MRBM brigades in southeast China.
- Headquartered in Kunming, the 53 Base manages two medium range ballistic missile brigades in Yunnan and two GLCM brigades located in the provinces of Guangxi and Guizhou.
- Luoyang's 54 Base commands three intercontinental ballistic missile brigades concentrated in Henan.
- Headquartered in the western Hunan city of Huaihua, the 55 Base consists of three ICBM brigades in Hunan and one GLCM brigade in neighboring Jiangxi province.
- From Xining city in Qinghai, the 56 Base oversees four brigades operating in Qinghai, Xinjiang, and Gansu.
- The Second Artillery centrally stores most of the country's nuclear warheads in Taibai County, deep in the Qinling Mountains of Shaanxi Province.[12]

Second Artillery headquarters also oversee a number of direct reporting operational support units. For example, a regiment-sized unit north of Beijing specializes in all-source intelligence, and would likely be deployed to a theater command center as the intelligence cell.[13] At least one, and probably two, electronic countermeasures (ECM) regiment would support the Second Artillery component commander within a Joint Theater Command.[14] A central depot north of Beijing stores non-mission essential supplies for the entire force.[15] Education for new officers is carried out at the Second Artillery Engineering Academy in Xian. This educational facility supplies approximately 88% of all launch brigade commanders, 75% of the brigade chiefs of staff, and 90% of engineering department directors.[16]

The Second Artillery relies on an expansive defense industrial R&D and manufacturing supply chain for its weapons and systems. Details on the acquisition process, including development of operational requirements, are unavailable at the current time. However, two large state-owned enterprises – the China Aerospace Science and Industry Corporation (CASIC) and China Aerospace Science and Technology Corporation (CASC) – are known to design, develop, and manufacture missile systems for the Second Artillery through the PLA's procurement agency, the General Armaments Department (GAD).[17]

For military-industrial coordination and quality control, the Second Artillery maintains 18 representative offices in key CASIC and CASC locations as well as in other research, development, and manufacturing centers. As a new missile variant is being developed and tested, a select group of field grade officers forms a regimental-level "seed unit" [种子队]. The unit familiarizes itself with the R&D design team, assembly plant, and supply chain and develops tactics and maintenance procedures, as well as simulation systems, to ensure the smooth introduction of the new variant into the operational inventory. The seed unit that is introducing a new missile variant in the Second Artillery is often attached to an existing brigade equipped with a similar airframe for administrative, training, and other support. The unit transitions to a new location and eventually upgrades to brigade status once it is equipped with new missiles and attains full operational capability.[18]

## Short Range Ballistic Missile Infrastructure

The Second Artillery's SRBM infrastructure is a central component of the PRC's coercive political and military strategy. In 2000, China's SRBM force was limited to one "regimental-sized unit" in southeastern China. Today, the force has grown to at least seven SRBM brigades. Among these, five are subordinate to the Second Artillery's 52 Base and the remaining two units report directly to military regions.[19]

The CASC DF-15 and CASIC DF-11 SRBM systems have roots in the 1980s. Encouraged to enter the export market to offset declining domestic demand for defense production, formal R&D on the DF-15 began in April 1985. Active international marketing began in November 1986, when the missile was displayed during a Beijing defense exhibition. The space and missile industry concluded an

agreement for the sale of the M-9 to Syria in early 1988 before flight testing and design finalization.[20] CASIC's 066 Base in Hubei also entered the competition and began development of a 300 kilometer range DF-11 (export designation: M-11) solid fueled ballistic missile in 1985. The DF-11 was successfully flight tested in 1990, and initial contract for sale in Pakistan was signed in early 1991.[21] In the wake of its success in producing the first batch of DF-11 missiles for ground forces, the 066 Base worked to double the range of the DF-11 without compromising accuracy.[22]

With a 1988 decision to deploy ballistic missiles in a conventional role, the PLA's SRBM build-up opposite Taiwan began with establishment of a seed unit on August 1, 1991. Under the guidance of 52 Base's Major General Yang Yegong, the team consisted of 11 junior and field grade officers under the leadership of then Lieutenant Colonel Gao Jin.[23]

Major General Gao Jin, 52 Base Commander. Source: CCTV.

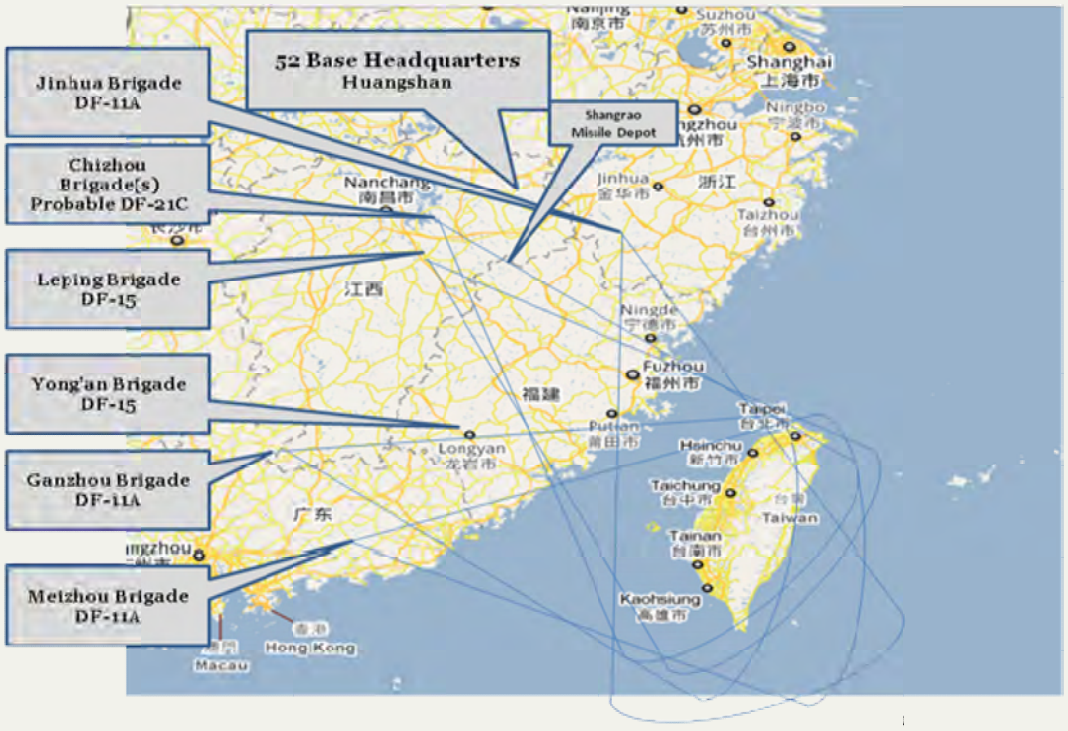
Today, Major General Gao Jin commands the world's largest and most lethal SRBM force in the world. However, the number of missiles in the Second Artillery, widely cited as exceeding 1,300 (including tactical missiles assigned to ground forces), may be less relevant than how they are organized and prepared for deployment.

A standard SRBM brigade consists of six battalions; each including two companies and at least two or three launchers are assigned to each company.[24] Therefore, a combined force of five brigades could theoretically could leverage between 120 and 180 mobile launchers to carry out a salvos fired from multiple axes to saturate missile defenses, paralyze airbases by damaging runways, and attack other military infrastructure. In addition to the launch battalions, a brigade headquarters oversees a command post, a technical battalion, a communications battalion, an ECM group, and an established rail transfer point.[25]

Since at least 1994, a specialized regiment reporting to 52 Base headquarters appears to store most SRBMs, related assemblies, and components at a hardened facility in Shangrao County, with annexes in the Qimen and Leping areas.[26] A specialized test and measurement unit is collocated with the maintenance support depot for missile components.[27] Arrayed against Taiwan are at least five SRBM brigades subordinate to Second Artillery, the PLA's primary strategic strike force:

- **Leping SRBM Brigade (96165 Unit).** The first SRBM brigade to be established opposite Taiwan is situated in the Jiangxi city of Leping. Accepting its first delivery of SRBMs in April 1992 and formal establishment as a brigade in 1993, the Leping brigade's first operational SRBM test launch was on November 23, 1993. Known as the Excalibur Brigade [*shenjian diyi lu;* 神剑第一旅] and for its role in the 1995 and 1996 missile exercise off the coast of Taiwan, the Leping brigade is likely equipped with the DF-15B SRBM, which replaced the older DF-15A variant as early as 2001 and was showcased during the October 2009 National Day parade.[28]

- **Yong'an SRBM Brigade** (96167 Unit). The second SRBM brigade, headquartered in the Fujian Province city of Yong'an, is reportedly equipped with the DF-15A or DF-15B SRBM. Yong'an's "Missile Launch Vanguard Battalion" [导弹发射先锋营] was awarded one of the country's highest honors by Jiang Zemin in January 2005.[29]
- **Meizhou SRBM Brigade** (96169 Unit). Located in the eastern edge of Guangdong province near Fujian, establishment of the Meizhou brigade marked the initial introduction of the 600 kilometer range DF-11A SRBM. Its six battalions appear to be located within a 60 kilometer radius of Meizhou, specifically in the areas of Nankou Village, Fengshun County, Xiyang Village, and Pingyuan County.[30]
- **Ganzhou SRBM Brigade (96162 Unit).** Located in southern Jiangxi Province, the Ganzhou brigade appears to be the second DF-11A brigade to have been established. Operating areas appear to be in Zhanggong County, Ruijin City, Yudu County, Nankang City, and Xinqiu County.[31]
- **Jinhua SRBM Brigade** (96164 Unit). Another brigade, most likely equipped with the DF-11A SRBM, is located in the area of Jinhua, Zhejiang Province. The brigade commander, Colonel Zhang Jianqiang [张建强], was an original member of the initial SRBM seed unit in the early 1990s.[32]




Second Artillery's short range ballistic missile brigades. Source: Google Maps.

The SRBM brigades appear to be stepping up their training program. In 2009, China's state-run media announced that the Second Artillery and PLAAF had conducted one of the largest joint exercises to date in northwest and northeast China. Deploying from home bases in southeast China, the Second Artillery contingent was the lead service in the exercise and was represented by 5,000 soldiers from four SRBM brigades. They were supported by two PLAAF divisions and a radar brigade.[33]

## Medium Range Ballistic Missiles

Having established a solid foundation in conventional SRBMs, the PLA has begun to extend and diversify the warfighting capacity of the Second Artillery's ballistic missile force. The centerpiece of the Second Artillery's regional mission is the two stage, solid fueled DF-21 medium range ballistic missile (MRBM). The first DF-21 system with a dedicated nuclear mission entered the Second Artillery's operational inventory in 1991 and gradually replaced older liquid-fueled DF-3A intermediate range ballistic missile systems. A seed unit has been established at early as 1985 to work with industry to develop tactics and maintenance procedures.

Design work on a follow-on variant, the DF-21A, began in 1988, with initial flight testing in April 1992. Tested to a maximum range of 3,000 kilometers, the DF-21A design was finalized in 1997 and conversion to the longer range DF-21A began taking place in the late 1990s and early 2000s.[34] The CASIC Fourth Academy has been responsible for the design, development, and manufacturing of all DF-21 variants. More specifically, the Fourth Academy's 307 Factory in Nanjing is reportedly responsible for assembling the DF-21C, as well as the DF-21D maritime strike variant in the future.[35]

Over the next five to 10 years, the centerpiece of the Second Artillery's extended range conventional strike capability will be the DF-21C MRBM. Capable of both conventional and nuclear missions [*hechang jianbei*; 核常兼备], the DF-21C's guidance, navigation, and control system is modeled after the U.S. Pershing II. The terminally-guided DF-21C can deliver a 2,000 kilogram warhead to a range of at least 1,750 kilometers with a circular error probability of less than 50 meters. The system could be used for conventional strikes against targets throughout Japan from east and northeast China, New Delhi if based in Xinjiang, and western India if based in Yunnan.[36]

The Second Artillery has an operational force structure of at least eight, and possibly as many as 10, brigades equipped with a DF-21 variant. Trends indicate that conventionally capable variants are gradually replacing at least a portion of the force's DF-21A inventory. Standard DF-21C force structure appears to mirror that of SRBM brigades with each brigade having six launch battalions with two companies each. Assuming a single launcher is assigned to each company, a DF-21C brigade could be initially equipped with 12 launchers.[37]

In its 2009 Report to Congress on PRC Military Power, the Department of Defense estimated that 20 to 40 MRBMs and a slightly lower number of launchers are being produced annually.[38] However,

China's defense industrial and operational infrastructure indicates significant capacity for growth. The Report noted that China's capacity for MRBM production may have doubled. This assessment is supported by Chinese aerospace industry reporting.[39]

The following units are leading candidates for the conventional DF-21C MRBMs:

- **Laiwu MRBM Brigade** (96117 Unit). The first brigade to be equipped with the conventional-capable DF-21C is home-based in the suburbs of Laiwu, Shandong Province.[40] At least one reference indicates that a new Second Artillery brigade may be in the process of being formed near Laiwu, specifically in the vicinity of the Shandong Province city of Qingzhou (alleged the 96119 Unit).[41]
- **Qimen MRBM Brigade (96163 Unit).** A well established Second Artillery brigade near Qimen, Anhui Province, may be the second DF-21 unit to upgrade to the dual capable DF-21C. The Qimen brigade participated in a combined arms exercise in December 2009 in the Jinan Military Region.[42]
- **Kurle MRBM Brigade (96365 Unit).** A relatively new brigade that may be equipped with the DF-21C is home-based in the Xinjiang city of Kurle. Established in 2006, media reporting indicated that the unit conducted a short notice exercise in which it deployed 200 kilometers within three hours upon order.[43]
- **Possible Chizhou MRBM Unit** (96166 Unit). A new Second Artillery launch unit is being formed in the vicinity of an existing DF-21 brigade (96161 Unit) in Chizhou City municipality. Established in the 2006 timeframe, the unit appears to still be in its formative stage and is not yet a full brigade.[44] Its proximity to an existing MRBM brigade could permit the new unit to leverage its logistical infrastructure until it upgrades to a full brigade. The unit leadership has extensive experience with conventional ballistic missile operations, specifically the Yong'an brigade.[45]
- **Possible Chuxiong/Qingyuan MRBM Unit** (96219 Unit). Beyond these, a relatively new launch unit has been identified in the general vicinity of a well-established DF-21 brigade in Chuxiong (96213 Unit). Collocation of a regimental-level seed unit with an existing brigade equipped with the same basic missile airframe allows for the sharing of administrative, logistical, training, and technical support until a new missile variant enters the operational inventory of the new seed unit. Once the seed unit is designated as a full launch brigade, one of the brigades will relocate to its permanent home. Media reporting indicates that the 96219 Unit is gradually establishing a presence in the Qingyuan municipality in Guangdong Province.[46]

Remaining units that may eventually transition into the dual capable DF-21C variant includes the well-established DF-21 brigade based near Tonghua, Jilin Province, which may have converted to the longer range DF-21A in 2002.[47] Eventual conversion of the sole remaining DF-3 brigade (96113 Unit,

Jinzhou, Liaoning Province) to a new missile variant is possible in the next several years. Well established DF-21 brigades are reportedly based in Jianshui, Yunnan Province (96211 Unit) and Datong in Qinghai Province (96361 Unit). A relatively new brigade will possibly be established to support training is located near Delingha, Qinghai Province (96367 Unit).[48]

## Ground Launched Cruise Missiles

To augment its ballistic missile arsenal, Second Artillery is steadily expanding its ground launched LACM infrastructure. GLCMs are powerful instruments of military and political utility due to the inherent difficulty in defending against them.[49] Notably, the stationing of U.S. GLCMs in Western Europe in 1982 proved to be an effective political-military counter to the Soviet military build-up, and an asymmetric response to deployment of the lethal SS-20 intermediate range ballistic missiles.[50]

Within only a few years of initial deployments, the PRC today has the world's largest inventory of extended range GLCMs. Able to penetrate defenses and strike critical targets on land, out to a range of at least 2,000 kilometers, the Second Artillery's DH-10 LACMs appear to have enjoyed a relatively high acquisition priority. Home based in south-central and southwestern China and highly mobile via rail, cruise missiles are able to strike from any direction, presenting a challenge for the defender with their low altitude trajectories.[51]

The CASIC Third Academy's Third Design Department oversaw DH-10 design, development, and testing.[52] With a supply chain that spans dozens of sub-contractors, low rate initial production of LACMs began after final acceptance testing on both land- and air-launch variants in late July 2003. LACM components, including engine, guidance, navigation, and control sub-systems were assembled at the 159 Factory in Beijing's Fengtai District[53] with engineering and digital scene matching area correlation (DSMAC) support provided by a specialized unit in Beijing. The DH-10 is deployed on a three-tube road mobile launcher[54] and approximately 100 LACMs enter into the operational inventory each year.[55]

- **Liuzhou GLCM Brigade** (96215 Unit). With development efforts underway, the Second Artillery established a regimental-level seed unit under 53 Base in the Liuzhou area of Guangxi Province in 2000. After final acceptance testing in July 2003, the regiment conducted its first operational test firing in October 2003, and by 2006, it had converted to brigade status. Identified as a rapid reaction unit for cross-country deployments and trained in concealment, the brigade is organized along similar lines as its SRBM and MRBM counterpart units – six launch battalions consisting of two companies each.[56]

Possible 96217 Unit GLCM-Related Facility, Sanya City.
Source: Google Earth.

- **Guiyang GLCM Brigade** (96217 Unit). Members of the original cadre from the GLCM seed unit in Liuzhou have begun to transfer to new units, such as a relatively new brigade that has been established in the vicinity of Guiyang, Guizhou Province. While unconfirmed, the Guiyang brigade could be the second GLCM unit under 53 Base or a perhaps specialized training base for GLCM operations.[57] Furthermore, the Guiyang brigade appears to be establishing a forward presence in the suburbs of Sanya City on Hainan Island. From Hainan, a GLCM with a range of at least 2,000 kilometers could cover the South China Sea, Strait of Malacca, and the Nicobar and Andaman Islands. The brigade's compound, currently under construction near Sanya, is also within 15 kilometers of the PLA Navy's new Yalong Bay submarine base.[58]
- **Yichun GLCM Brigade** (96317 Unit). Another GLCM brigade reportedly operates under the 55 Base in the area of Yichun City in Jiangxi Province. The brigade has been reported to be a rapid reaction unit and has conducted live fire training in Gansu Province.[59]

In short, the PRC has the fastest growing and most sophisticated extended range ground-launched LACM infrastructure in the world. Based in south-central and southwest China, two or possibly three Second Artillery GLCM brigades would be able to rapidly forward deploy in a crisis situation.

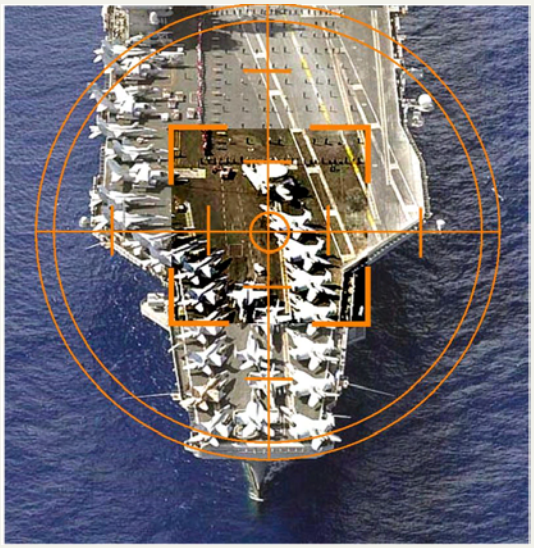
## Anti-Ship Ballistic Missiles and Beyond

Authoritative Chinese writings indicate research into, and the development of, increasingly accurate and longer range conventional strategic strike systems that could be launched from Chinese territory against land- and sea-based targets throughout the Asia-Pacific. An imminent manifestation of long term intent would be the deployment of conventional MRBMs capable of engaging naval combatants, including aircraft carrier battle groups, in the western Pacific Ocean.[60]

An effective ASBM and persistent maritime surveillance capability could complicate the capacity of the United States to resist PRC use of force against Taiwan, thus undermining the letter and spirit of the Taiwan Relations Act (Public Law 96-8). Such conventional precision strike assets may also reflect intentions to enforce other regional sovereignty claims and secure sea lines of communication. Over the longer term, successful development and deployment of intermediate- and intercontinental-range conventional ballistic missiles as well as other precision strike assets would offer the PRC

political leadership a flexible deterrent that could achieve strategic and operational effects against an enemy in a crisis.

Many of the basic technologies needed for a rudimentary ASBM capability have been in development for more than 20 years. At the core of this capability is an advanced missile-borne sensing and data processing system supported by strategic cueing from a dual-use maritime surveillance network. Barring deployment of effective defenses, an ASBM will give the PLA a precision strike capability against aircraft carriers and other U.S. and allied ships operating 1,500 to 2,000 kilometers from the eastern coast of China.



ASBM – a challenge to U.S. carriers in the Western Pacific

Manufacturing facilities for solid rocket motors associated with an initial ASBM variant, designated as the DF-21D, appear to have been constructed in 2009. Flight testing of a new motor and airframe is likely underway.[61] Integrated flight testing of the airframe, motor, guidance, navigation, and control systems against a target at sea will likely be the final step in the design certification process.[62]

A seed unit has likely been established and home base selected for the initial introduction of the maritime variant of the DF-21 into the Second Artillery.[63] Its deployment in Guangdong could offer coverage of both the Western Pacific and South China Sea. Furthermore, follow-on variants could extend an ASBM's range out to Guam, and incorporate more sophisticated trajectories and missile defense countermeasures.

Over the longer term, Chinese technical writings indicate the preliminary conceptual development of a conventional global precision strike capability. The accuracy and range of the PLA's conventional ballistic missile force is also expected to improve significantly over the next 10 to 15 years as missiles incorporate more advanced inertial and satellite aided navigation systems, sophisticated terminal guidance systems, and increasingly powerful solid rocket motors.

## Conventional Air Modernization

While the Second Artillery has expanded significantly, PLAAF modernization has progressed at a more modest pace.[64] The PLAAF has been diversifying its roles and missions, moving away from a force exclusively responsible for air defense, interdiction, and close air support for ground forces toward a service whose primary mission is deterrence and strategic attack. The PLAAF's diversification is grounded in a body of theories which stipulate that a firepower warfare campaign could independently support national objectives. The predominant operational focus of the Air Force is denial - paralyzing an adversary's capabilities to the extent that further resistance appears futile

and the costs of continued resistance outweigh surrender. However, the PLAAF envisions its future role as an independent service capable of conducting strategic strike missions at extended ranges in support of national objectives.

Given resource constraints and the overlap in the core mission of strategic strike, the rapid rise of the conventional Second Artillery may have contributed to the slow pace of PLAAF modernization.[65] The rapid deployment of ballistic missiles and GLCMs has dampened the requirement for an offensive-oriented Air Force. Another possible constraint has been the limitations of China's aviation industry and its corresponding reliance on foreign procurement of key systems. Nevertheless, over the coming decade, a capable and technologically advancing domestic aviation industry may be positioned to better support the PLAAF's vision of becoming a world-class service capable of conducting air campaigns independent of the Second Artillery.

To close the gap between its doctrinal aspirations and actual capabilities, the PLAAF has made significant investments into force modernization over the last 20 years. Since the introduction of the first conventional ballistic missile into Second Artillery inventory in 1991, the PLAAF has procured new multi-role fighters, invested in sophisticated ground-based air defenses, upgraded existing airframes, procured airborne early warning (AEW) and aerial refueling platforms, and introduced advanced electronic warfare systems.

Senior PLAAF representatives have outlined general requirements for meeting expected strategic challenges. According to China's 2008 Defense White Paper, "the Air Force is working to accelerate its transition from territorial air defense to both offensive and defensive operations, and increase its capabilities for carrying out reconnaissance and early warning, air strikes, air and missile defense, and strategic projection, in an effort to build itself into a modernized strategic air force." Guided by the development strategy of "integrated air and space, and combined offense and defense [空天一体, 攻防兼备], senior PLAAF leadership note that required capabilities include the capacity to carry out long range precision strike, an ability to attain local or limited air superiority, stealth, "full spectrum" air and missile defense, new "trump card" [撒手锏] weapon systems, long range airlift [远程投送], and unmanned aerial vehicles.[66] As PLAAF Commander Xu Qiliang argued in a recent media interview, integrating air and space operations is needed to ensure strategic dominance on the sea and ground.[67]

The PLAAF's long term vision is to be able to conduct an independent air campaign to achieve decisive strategic effects. Such a goal should not be surprising. Since the publication of Giulio Douhet's *Command of the Air* in 1921, airpower proponents in China have envisioned the transformation of warfare through long-range strategic strikes. PLAAF representatives have argued in favor of a gradual transition from supporting ground forces in defensive counterair missions and close air support, to joint operations, and finally to a fully independent service able to conduct strategic strike missions at extended ranges.[68]

With a long term outlook in mind, the PLAAF is gradually improving its capabilities. The Air Force's current force structure is a mix of systems procured from Russia and from China's own aviation industry. Conventional air platforms include Su-27 air superiority fighters, which were procured from Russia in the early 1990s. A Su-27 variant, the J-11, is assembled in Shenyang. The PLAAF's first indigenously produced fourth generation fighter, the J-10, is assembled in Chengdu, and with at least three regiments equipped with the airframe already, the J-10 will gradually make up the bulk of its fighter force.[69]

The backbone of the PLAAF's long range precision strike capability is the Russian Su-30MKK multi-role fighter, a rough equivalent to the U.S. Air Force's F-15E. The PLAAF's fleet of 76 Su-30MKK fighters is augmented by three regiments equipped with the JH-7A, which is gradually replacing the older Q-5. The JH-7A is reportedly capable of firing the YJ-91/Kh-31P high speed anti-radiation missile, indicating a primary role in suppressing of enemy air defenses. The PLAAF's bomber fleet is still equipped with H-6 bombers, with indications of an upgraded variant capable of launching long range LACMs.[70] Equipped with aerial refueling, supported by initial Second Artillery firepower and AEW assets, the PLAAF is rapidly improving its ability to conduct interdiction missions at extended ranges beyond China's periphery.[71]

Over time, PLAAF capabilities are likely to expand more rapidly than in the past. For example, PLAAF Deputy Commander He Weirong outlined the PLAAF's intent to procure a next generation fighter over the next eight to 10 years.[72] Investments are being made into fielding an advanced active electronically scanned array (AESA) radar, and the GAD has a dedicated expert working group with the purpose of achieving breakthroughs in stealth technology.[73] According to one detailed Taiwanese assessment, the PLAAF had set a goal to be able to conduct an air campaign within a 1,000 kilometer radius of China's periphery by 2010 – one that has not been successful to date – and extend the range to 3,000 kilometers by 2030.[74]

In sum, the PLA Air Force is making modest progress in developing advanced capabilities with an eye toward expanding its operational range. The ability to carry out strategic strike missions at ranges of 3,000 kilometers or more is viewed as the key to becoming a truly independent service, rather than one dependent on Second Artillery or restricted to a supporting role for the ground forces. Despite the PLAAF's aspirations to develop a force capable of an independent air campaign around China's periphery, senior PRC political and military authorities will likely continue to rely on the established capabilities of the Second Artillery for coercion, strategic strike missions, and suppression of enemy air defenses for some time to come.

## Electronic Warfare

The PLA is supplementing theater missiles and air operations with increasingly sophisticated electronic attack systems. Leveraging advances in information technology, the PRC is improving its electronic surveillance, attack, and defense capabilities. During peacetime, ECM regiments are an

integral part of field exercises under the doctrinal concept of "war under electromagnetic conditions" [复杂电磁环境下的战场条件]. Preceding and during missile and air attacks, electronic warfare could pose challenges to the integrity and reliability of an adversary's situational awareness and communications by disrupting wireless, satellite, and radar networks. The PLA also views ground-based jammers as an integral part of its air defense system. In short, electronic warfare operations would be integrated with the physical destruction of command and control centers, early warning sites, and air defense systems to reduce the effectiveness of an enemy's communications system and to effect systemic paralysis.[75]

The PLA places a high priority on disrupting or exploiting communications networks. Under certain conditions, ECM assets are capable of disrupting an enemy's leadership and operational-level communications. China's defense industry is also designing and developing means of jamming U.S. JTIDS/Link 16 networks and Global Positioning System (GPS) satellite signals.[76] Concurrent to jamming, PLA computer network attack specialists would target automated enemy command systems through the use of insiders who have penetrated internal networks and/or through pre-planted viruses into automated air defense networks.[77] In addition, false communications networks, mimicking real ones, would be launched in an attempt to deceive enemy intelligence assets. Special emphasis has also been placed on jamming missile defense radar systems.[78]

The PLA's electronic warfare infrastructure has expanded dramatically over the last decade. The PLA General Staff Department's (GSD) Fourth Department leads joint force planning and development of requirements, and also oversees one or possibly two direct reporting ECM regiments. The first is a brigade-level organization based in Langfang with subordinate elements in Anhui, Jiangxi, and Shandong. The other, located on Hainan Island, appears to have either operational or experimental satellite jamming responsibilities.[79] Second Artillery headquarters also directs one or possibly two ECM regiments, and SRBM brigades also have battalion-level ECM units for point defense against air strikes. The Air Force has also expanded its airborne ECM capabilities, with specialized regiments being formed in each military region. One of these regiments is likely responsible for operating unmanned combat aerial vehicles to target air defense radars.

## Sensor Architecture and Integrated Air and Space Defense

The PLA's ability to conduct strategic and operational strike missions is likely to be restricted by the range of its persistent surveillance. To expand its battlespace awareness, the PLA is investing in at least four capabilities that could enable it to monitor activities in the Western Pacific, South China Sea, and Indian Ocean: 1) near space flight vehicles; 2) space-based satellites; 3) airborne platforms; and 4) land-based over the horizon radar systems.

**Persistent Near Space Surveillance**. Chinese analysts view the realm between the atmosphere and space – "near space" – as an area of future strategic competition.[80] Over the decade, near space flight vehicles (*jinkongjian feixingqi*; 近空间飞行器) may emerge as a dominant platform for a

persistent region-wide surveillance capability during crisis situations.[81] Near space is generally characterized as the region between 20 and 100 kilometers (65,000 to 328,000 feet) above the earth's surface. The 100 kilometer altitude point, sometimes called the Karman Line, is a rough border dividing the earth's atmosphere and outer space. The near space realm is too high for fighter jets and too low for orbiting satellites. However, coverage from platforms similar to satellites in low earth orbit could offer significant improvements in resolution. Duration of flight for near space vehicles far exceeds that of UAVs and their small radar and thermal cross-sections make them difficult to track and target. Partially powered by high efficiency solar cells, near space vehicles are viewed as a relatively inexpensive means of persistent broad area surveillance.[82]

While technical challenges exist, the Second Artillery and China's defense R&D community have become increasingly interested in near space flight vehicles for reconnaissance, communications relay, electronic countermeasures, and precision strike operations.[83] For reconnaissance missions, synthetic aperture radar (SAR) surveillance and electronic intelligence appear to be priorities.[84]

In order to overcome technical challenges, China's aerospace industry, specifically CASC and CASIC, have established new research institutes dedicated to the design, development, and manufacturing of near space flight vehicles.[85] The 068 Base in Hunan province established a Near Space Flight Vehicle R&D Center in 2005 and its initial projects include the JK-5, JK-12, and JKZ -20 airships.

Similarly, the 10th Research Institute under CASC's China Academy of Launch Technology (CALT, or CASC First Academy) was formed in October 2008 after two years of closed door meetings, conferences, and feasibility studies for the design and development of sensor and possibly strike systems that exploit the unique characteristics of near space.[86] Establishment of a dedicated CALT research institute for leveraging the unique characteristics of near space signifies the importance that China places on this domain.[87] Most recently in June 2009, a CASC manufacturing facility in Chengdu (7304 Factory) initiated testing on an engine designed to support a near space flight vehicle program.[88]

**Space-Based Surveillance**. Increasingly sophisticated space-based systems would expand PLA battlespace awareness and support strike operations further from Chinese shores.[89] Space assets enable the monitoring of naval activities in surrounding waters and the tracking of air force deployments into the region. Space-based reconnaissance systems also provide imagery necessary for mission planning functions, such as navigation and terminal guidance for LACMs. Satellite communications also offer a survivable means of communication that will become particularly important as the PLA operates further from its territory.

The PRC has embarked on a major dual-use, civil-military space program that is predominantly driven by the desire to stand among equals in the international community.[90] However, as in most space programs, there is a military stake. A number of authoritative journals have advocated accelerating and expanding China's space-based surveillance system, including the need for a "space-based theater electronic information system" covering an area of 3,000 square kilometers.[91] Another

indicator is unverified sources which report that a strategic cueing network for an ASBM capability, relying on dual-use satellite architecture, is being implemented ahead of schedule.[92]

A regional strike capability would partly rely on high resolution, dual-use space-based SAR, electro-optical (EO), and possibly electronic intelligence (ELINT) satellites for surveillance and targeting. China's space industry is reportedly nearing completion of its second generation SAR satellite, and its EO capabilities have been steadily progressing. While information is sparse, indications exist that at least some funding has been dedicated toward developing a space-based ELINT capability.[93] In a crisis situation, China may have the option of augmenting existing space-based assets with microsatellites launched on solid-fueled launch vehicles. Existing and future data relay satellites and other beyond line of sight communications systems could transmit targeting data to and from the theater and/or Second Artillery's operational-level command center.[94]

**Over the Horizon Radar.** In addition to space-based, near space, and airborne sensors, over the horizon backscatter (OTH-B) radar systems would be a central element of an extended range air and maritime surveillance architecture.[95] Managed by the PLAAF, an OTH radar system could define the range of China's maritime precision strike capability. Skywave OTH radar systems emit a pulse in the lower part of the frequency spectrum (3 to 30MHz) that bounces off the ionosphere to illuminate a target – either air or surface – from the top down. As a result, detection ranges for wide area surveillance can extend between 1,000 and 4,000 kilometers.[96] In addition to resolution issues, Chinese sources cite challenges stemming from sea clutter that makes it difficult to discriminate between ocean targets. However, engineers are confident in the ability of OTH radar systems to detect aircraft carriers, airborne assets, and other targets operating with range of the radar system.[97] Known as the "skywave brigade," a PLAAF unit mans a watch center south of Hubei City in Xiangfan. The brigade also operates transmitter and receiver sites, and ionosphere measuring stations along China's southeast coast.[98]

**Integrated Air and Space Defense.** The PLA's expanding sensor architecture is an integral component of China's evolving concept for integrated air and space defense. Led by CASIC, China is aggressively modernizing its surface-to-air missile capability by upgrading current systems, fielding new generation SAMs, and procuring foreign systems.

Over the last 15 years, the PLA has invested significant resources into enhancing its air defenses through the acquisition of advanced Russian double digit surface-to-air missile (SAM) assets, such as the SA-10B, SA-20 PMU1, and SA-20 PMU2 systems, as well as the SA-15. The PLA has also been developing indigenous systems, such as the HQ-9. With these acquisitions and an advertised intercept range of 200 kilometers, the effective envelope of the PRC's air defense network has been extended well into the Western Pacific. China's electronics industry also has been engaged in R&D on bistatic, multi-static, and ultra-wideband (UWB) radar systems that could reduce the effectiveness of older stealth airframes, such as the F-117 and B-2.

Integrated air and space defense also includes an ability to counter foreign space-based surveillance and ballistic and land attack cruise missiles.[99] Following a 15 year three-phased missile defense development plan in 1996, China's space and missile industry conducted successful tests in January 2007 and January 2010, thus demonstrating an ability to intercept satellites in low earth orbit and rudimentary MRBMs during the mid-course of their flight.[100]

Insufficient information is available to assess which service would be equipped with anti-satellite/mid-course missile defense systems once a viable capability is ready to be fielded. However, the Second Artillery and the PLAAF appear to have been competing for the operational space control and intercept mission.[101] For example, an internal Second Artillery text references a "Second Artillery space operations unit" [二炮太空作战部队] with an operational support function.[102] One analysis explains that the aerospace defense domain would be divided along the Karman Line - the PLAAF would assume the air defense mission for threats below 100 kilometers while the Second Artillery would be responsible for threats above 100 kilometers.[103]

The PLA's growing aerospace capabilities is supported by an increasingly sophisticated command, control, and communications architecture. The emphasis has been on high capacity fiber-optics; switching systems, satellite communication systems; digital data links, and systems integration and data fusion. In 1986, China's telecommunications community embarked on a long-term, dual-use program valued at U.S. $200 billion. By the end of 1995, China had constructed ten of the largest networks in the world and the PLA had set a goal of laying more than 200,000 kilometer of fiber optic cable by 2005.[104] Observers noted China could develop one of the world's most advanced telecommunications infrastructures.[105]

In summary, a PLA aerospace campaign intended to coerce an adversary would emphasize preemption, surprise, and concentration of its most advanced assets to achieve a measure of shock. In order to effectively guide a campaign, command and control would be centrally planned and executed by the Joint Theater Command. It would also be supported by other joint command systems, including a joint Firepower Command Center, as well as command centers that oversee component operations of the PLAAF and the Second Artillery. The PLAAF, while technologically behind the U.S. Air Force and others, is evolving into a force capable of dominating the skies around its periphery, with support from the Second Artillery and information warfare assets.

# Regional Scenarios

The PRC's expanding capacity for conducting an aerospace campaign in the Asia-Pacific region would likely be a variable of its territorial disputes with states around its periphery. As its military strength increases relative to those of its neighbors, the PRC could feasibly become more assertive in its claims.[106] Along this trajectory, miscalculations, accidents, disputes over sovereignty, or other unforeseen events have the potential to escalate into armed conflict between the PRC and its neighbors.


China's territorial disputes. Source: DOD China Military Power Report, 2009.

On the other hand, others view China's modernization as more strategic in nature and a bid to challenge to the United States as well as the current balance of power in the Asia-Pacific region. Referring to China's ambitious military modernization program, former U.S. defense officials Michael Green and Paul Giarra explain:

> *These developments are designed to re-order the balance of power in China's favor by diminishing American strategic mobility and free access to Pacific waters, Pacific airspace, and the "high terrain" of space and cyberspace.*[107]

One approach to managing the PRC's evolving aerospace challenge, including the ASBM, is direct military-technical countermeasures. Countries with the greatest concern due to historical grievances and geographical proximity, including Taiwan, Japan, India, the United States, and others have been monitoring developments and assessing their security implications. While each defense establishment is approaching the challenges differently, most are attempting to balance interests in maintaining healthy relations with Beijing while at the same time hedging in the event of a future conflict.

## Taiwan

Taiwan serves as the principal coalescing driver for the PRC developing capabilities that seeks dominate the skies around its periphery. Through aerospace power, the PRC is steadily broadening its military options, including the ability to use force at a reduced cost in terms of PLA lives and equipment. Beyond simply expanding military options against Taiwan, the PRC is also is developing the means to deny or complicate the ability or willingness of the United States to intervene in response to its use of force.

Investment priorities include increasingly accurate and lethal theater ballistic missiles and LACMs; development and acquisition of multi-role fighters; and development of stand-off and escort jammers. Evolving capabilities include extended range conventional precision strike assets that could be used to suppress U.S. forward bases in Japan, aircraft battle groups operating in the Western Pacific, and perhaps over the next five to 10 years from U.S. bases on Guam.

While the PRC likely seeks an ability to do so, annihilation involving the physical occupation of Taiwan is perhaps the least likely course of action. When viewed from a coercive context, Beijing is already at war with Taiwan every day. The use of force spans along a continuum from "deterrence warfare," perhaps best demonstrated by Beijing's deployment of five Second Artillery SRBM brigades opposite Taiwan, all the way to annihilation. PRC decision makers are most likely to resort to coercive uses of force, short of a full scale invasion, in order to achieve limited political objectives. Coercive strategies could include a demonstrations of force as seen in the 1995 and 1996 missile exercises or 1999 flights activity around Taiwan; a blockade intended to pressure decision makers in Taiwan to assent to Chinese demands; a strategic paralysis involving attacks against the islands critical infrastructure; and limited missile strikes, just to name a few.

Prominent PLA political analysts believe that coercive approaches offer the optimal solution to minimize international repercussions in the wake of using force against Taiwan to achieve limited political objectives.[108] A coercive campaign could be geared toward inflicting sufficient pain or instilling fear in order to coerce Taiwan's leadership to negotiate on Beijing's terms, accelerating a timetable for unification, pursuing immediate political integration, or other political goals. Military coercion succeeds when the adversary gives in while still having the power to resist. It is distinguished from brute force, an action that involves annihilation and total destruction.

Most analyses of the cross-Strait military balance are based upon the worst case, and least likely, scenario involving a PLA amphibious invasion and physical occupation of Taiwan. In this scenario, air dominance is a necessary precondition. It is envisioned that large scale SRBM salvos will be carried out against ground-based air defenses, airbases, and other critical military infrastructure, and followed up by conventional PLAAF strikes to ensure air defenses remain suppressed. The Second Artillery's ability to suppress ground-based air defenses and damage runways would give the PLAAF the necessary advantage to attain air superiority over the Taiwan Strait. If successfully able to operate in the skies over Taiwan with impunity, PLAAF interdiction missions could effectively support an amphibious invasion.[109]

In the extreme case that violence is necessary, a fundamental PLA guiding concept is to compel a political concession swiftly, using only the minimal force necessary.[110] The goals and forms of coercive force that Beijing could exercise are limitless. Examples include daily artillery shelling of offshore islands, missile exercises off Taiwan's primary ports, intrusions into Taiwan-controlled airspace, or a missile strike against an uninhabited point in the central mountains of the island. In all cases, use of force is calibrated to manipulate the cost-benefit calculus of Taiwan's political and military leadership. This is premised upon the assumption that Taiwan's central leadership has a low threshold for pain and that a limited demonstration would produce the desired results.[111] As former ROC National Security Council Advisor and Deputy Minister of Defense Lin Chong-pin explains:

> *Beijing will reject the use of nuclear weapons, avoid city-destroying attacks with indiscriminate conventional weapons and use harassment tactics or unorthodox measures that are psychologically overbearing yet physically non-damaging.*[112]

In this environment, political considerations trump simple military solutions. Weapon systems and capabilities transcend the pure military realm and are fielded not only for their operational value but also to achieve political outcomes. The PRC's arsenal of five SRBM brigades not only has significant military value, but also political and psychological effects. In a similar vein, the political value of Patriot PAC-3 systems, F-16s, and Hsiungfeng-2E (HF-2E) LACMs are equally as important as their military, political and psychological utility to Taiwan.

Yet a relative erosion of Taiwan's military capabilities, especially in aerospace power, could create opportunities and incentives for Beijing's political and military leadership to assume greater risk in cross-Strait relations, including resorting to force to resolve political differences. Among the most significant aspects of Taiwan's aerospace power include its conventional air force assets, missile defenses, and strategic strike capabilities.

**The ROC Air Force and Air Sovereignty.** The fundamental source of tension between Beijing and Taipei is disagreement over the sovereign status of Taiwan. By extension, regulating and controlling airspace over territory is also an exercise in sovereignty. In practice, air sovereignty involves the integrated tasks of surveillance and control in order to enforce a government's authority over its territorial airspace.

Responsible for ensuring air sovereignty, the ROC Air Force (ROCAF) has traditionally sought to maintain a fleet of approximately 400 fighters.[113] Its inventory today includes 56 Mirage-2000, 145 F-16 A/B, 126 Indigenous Defense Fighters (IDFs), and 60 F-5E/F fighters. With its F-5s reaching the end of their operational life, and the entire Mirage, IDF, and F-16 fleet all entering service in 1997, the ROCAF began long range planning for procurement of new fighters as early as 1999. Evaluating a range of options, including the AV-8B and F-35/Joint Strike Fighter (JSF), the ROCAF's first preference has been a vertical/short take off and landing (V/STOL) airframe. Initial requests for participation in the international JSF program were rebuffed. Former ROCAF Commander Liu Guili explained in 2006: "The (ROC) air force is open to any kind of VSTOL fighters, and is not necessarily aiming for the US' Joint Strike Fighters [JSF] that are in development."[114]

As the ROCAF F-5 fleet gradually retires over the next five years, planners foresee a widening fighter gap between now and 2020, the earliest that a VSTOL airframe could enter its operational inventory. To bridge the gap, the ROCAF has pursued acquisition of an additional 66 F-16 fighters through U.S. foreign military sales (FMS) channels. With F-16A/B Block 20s no longer in production, the C/D Block 50/52 variant is the closest to the technological level of the ROCAF's existing fighters.

ROCAF assets are deployed at seven airbases on Taiwan, with four on the west coast and three in the east. The primary challenge that the ROCAF faces is not its counterpart, the PLAAF, but rather the Second Artillery's potential ability to ground ROCAF fighters by damaging runways and other airbase infrastructure.[115]


Rapid Runway Repair Exercise. Source: Taiwan internet.

As a result, the ROCAF has been evaluating how to best maximize its ability to sustain flight operations after initial strikes. Central to the ROCAF's strategy are early warning systems, ground-based integrated air and missile defenses to thin out incoming missile raids, two hardened shelters on the east coast of the island, rapid runway repair (RRR) capabilities and swift clearing of unexploded ordnance. The underground aircraft storage facilities adjacent to Hualian Airbase and near Taidong are able to house more than half of the ROCAF's total fleet. The bases were designed to preserve the combat strength of the Air Force in the event of a first strike by the enemy.[116] While the facilities are formidable, Second Artillery LACMs could attempt to target vulnerabilities around the periphery of the bunkers.[117]

In order to open windows to generate sorties, the ROCAF and Taiwan's R&D community have been evaluating options and investing in RRR and unexploded ordnance equipment. The ROCAF has reportedly procured more than 350 RRR kits, with plans to procure at least an additional 175 sets. Exercises are reportedly conducted on a regular basis, including surveying craters and spalls, assessing minimum operating strips, and conducting repairs.[118]

It is worth noting that theater missile challenge to airbase operations is not new. Taiwan's airbase survivability problem bears a strong resemblance to that faced by NATO facilities in the 1980s as the Groups of Soviet Forces Germany and Warsaw Pact partners deployed increasingly sophisticated deep strike assets. Perhaps even more vulnerable are U.S. facilities on Okinawa in southern Japan that could support an intervention in the Taiwan Strait, as they are within striking range of the Second Artillery's Jinhua SRBM, MRBM brigades in eastern China, and forward deployed GLCMs.[119]

**Air and Missile Defenses.** Taiwan is also investing in early warning and terminal missile defenses in order to undercut the coercive utility of Second Artillery theater missiles. Its initial step has been procuring a long range early warning radar able to detect both air-breathing and ballistic targets at extended ranges through U.S. FMS channels. Building on existing PAVE PAWS technology, the radar system is to be situated on one of the taller peaks in the central mountain range and will be able to provide early warning of ballistic missile launches at distances of as far as 3,000 kilometers. The radar is also designed to monitor air targets over the Taiwan Strait and beyond at ranges of less than 200 kilometers, depending on the target's altitude and radar cross section.[120] The radar will augment existing and new radar systems deployed throughout Taiwan and its off-shore islands.[121]

Taiwan's terminal missile defense plans include upgrades to its three Patriot fire units to PAC-3 and the procurement of at least another four fire units. Taiwan is also said to be developing an indigenous missile defense system, the Tien-kung-3 (TK-3). Meanwhile, to counter low flying LACMs, upgrades to its short range air defense assets are under evaluation, along with elevated sensors for overcoming line of sight limitations.[122]

**Deep Interdiction Programs.** Taiwan has long maintained an ability to carry out deep strike missions against military targets in southeast China. To counter PRC coercion, Taiwan stresses maintenance of the necessary military strength as well as the ability to survive a first-strike attack and retaliate with a second-strike. For example, media reports alleged that Taiwan's leadership communicated to U.S. interlocutors their intent to strike a range of PRC air bases, missile bases, radar installations, and supply depots with indigenous fighters and tactical missiles during the March 1996 crisis. As one prominent advisor to the ROCAF, British air strategist Vice Marshal Tony Mason, explained in January 2001:

> *Any attack from the mainland, regardless of its timescale, would depend upon tight coordination to achieve its political objectives. Consequently, any delay, disruption or dislocation inflicted by even small-scale ROCAF attacks could have a disproportionate strategic and ultimately political impact.*

In the past, the ROCAF has earmarked a limited number of its fighters for strike missions, should a decision be made to take that course of action. However, with PLA air defenses growing increasingly sophisticated, Taiwan has been developing other means of maintaining a limited strike option. PRC sources indicate that Taipei has been developing its own answer to the Second Artillery's DH-10 GLCM – a land attack variant of the HF-2 anti-ship cruise missile, the HF-2E. In 2005, media reports

alleged that at least 24 launchers have been manufactured, along with an unknown number of missiles that could cover over 20 targets in southeast China.[123] More recently, media reports highlight further testing of the HF-2E in 2010, with plans to produce at least 80 HF-2E LACMs with a range of more than 500 kilometers by the end of 2010.[124]

## Japan

Unlike Taiwan, Japan's security concerns are primarily directed at North Korea. The chances for armed conflict between the PRC and Japan are slim, despite historical animosity and budding nationalist sentiments. However, unresolved territorial disputes and a more assertive China could lead to a crisis in the future. Japan faces an uncertain strategic environment with potentially volatile hotspots and shifting dynamics in regional aerospace power. North Korea, with its potentially unstable regime and diplomatic belligerence, poses a demonstrated nuclear armed security threat. Further north, an unresolved dispute with Russia over the Kuril Islands could also become a sticking point in Russo-Japanese relations. Beyond territorial disputes with China and South Korea over Takeshima/Dokdo, the situation across the Taiwan Strait and China's rapid military modernization remain potential flashpoints of concern.

With North Korea serving as the most immediate concern, Japan has been taking steps to modernize its defenses. Although a shift in the strategic environment could alter its direction, Japan has maintained an operationally defensive strategy, consisting of conventional air forces and ground based air defenses, to defend against threats from above. Relying on its alliance partner, the United States, for operations outside its territory, Japan's defense establishment has chosen to forgo theater missiles for strategic strike missions. As a result, it places a premium on early warning and engagement of inbound threats. Therefore, their priorities include the procurement of next generation fighters, integrated air and missile defenses, intelligence, surveillance, and reconnaissance systems.[125]

The Japan Air Self Defense Force (JASDF) maintains a fleet of more than 260 fighters, including 160 F-15J Eagles, and a mix of F-4 Phantom II and Mitsubishi F-2s, which are based on F-16C technology.[126] The JASDF plans to recapitalize its fighter fleet over the next 30 years. In particular, it is seeking to replace aging F-4EJ with 40-60 F-X aircraft beginning in 2015 and supplant the F-15 with new F-XX aircraft beginning in 2020. The JASDF is reportedly eyeing about 40 F-35s to make-up the elite vanguard of Japan's future fighter fleet, although other possibilities are under consideration, such the Eurofighter, the F/A-18E/F, and the F-15FX (a version of the F-15E).[127]

The JASDF is organized into four regional air defense forces, with the Western Air Defense Force (headquartered in Kasuga) and the Southwestern Composite Air Division (headquartered in Naha) most likely to be engaged in a crisis over disputed territories with China.[128] All four air defense forces are report to Japan's Air Defense Command Headquarters. With plans to relocate from Fuchu Air

Station in 2010, Japan's air defense network will be centrally controlled at an Air Defense Command (ADC) headquarters at Yokota Airbase.[129]

The command and control system will oversee a mix of ground based air defenses and fighter operations. First, the JASDF Base Air Defense Ground Environment (BADGE) system relies on 28 air defense radar sites.[130] Japan is beginning to deploy four FPS-5 along with seven improved FPS-3 long range early warning radar systems capable of detecting ballistic missile launches.[131]

Japan is establishing a layered, integrated air and missile defense system consisting of Patriot PAC-3 fire units for terminal defense against ballistic missiles and Aegis-equipped destroyers with Standard Missile-3 (SM-3) interceptors for mid-course defense. With its first unit deployed in March 2007, PAC-3 fire units are located at five bases around the country.[132] Eventually, 16 fire units covering Japan's major cities will be equipped with PAC-3 missiles. Media reports indicate that Japan is also equipping four existing and two planned destroyers with the SM-3 Block IA, and these upgrades will be deployed by 2011. Currently, a joint program between the U.S. and Japan is also seeking to produce an upgraded interceptor variant, the SM-3 Block IIA. Japan's Ministry of Defense (MOD) intends to link its missile defenses to its four FPS-5 radar sites and its seven upgraded FPS-3 radar sites via a C3 (command, control, communications) network known as the Japan Aerospace Defense Ground Environment (JADGE) by FY 2011.[133]

In light of the PRC's ambitious force modernization, Japan's SDF faces a number of challenges in the years ahead. Given the PRC's impressive advancements in ballistic and cruise missile technology; electronic, cyber, and anti-satellite capabilities; C4ISR developments, and conventional air modernization programs, trends suggest PLA capabilities relative the JSDF could enable the former to attain local air superiority over competing territorial claims at the outset of any future conflict. Among these challenges include the lack of hardening at key airbases and command and control facilities, shortcomings in cruise missile defense, and uncertainties surrounding procurement of a suitable next generation fighter.[134] Of the aforementioned vulnerabilities, loss of command and control facilities appears to be a particular shortcoming.

However, such comparisons ignore the two squadrons of U.S. F-16 CJ/DJ fighters deployed at Misawa airbase;[135] the two squadrons of U.S. F-15 C/D fighters deployed at Kadena airbase;[136] and Carrier Air Wing 5's forward deployed F-18 fighters at Naval Air Facility Atsugi.[137] Yet, the idea that the US could also lose air superiority over Japan is underscored by a RAND study which found that an attack on Kadena Airbase with 34 theater ballistic missile with submunition warheads could "damage, destroy or strand 75 percent of the aircraft based at Kadena."[138]

In the future, competing territorial claims in the Senkaku Islands could possibly lead to a military confrontation. In this unlikely yet possible scenario, the PLA could attempt to establish local air superiority over the contested area. This could be extended as far as control of the skies in southern Japan.[139] However, air dominance over the whole country is unlikely to succeed, due to the sheer

number of airfields in Japan, unless vulnerabilities in the national air defense system were identified and exploited.

As time goes on, the JASDF's requirement for a low-observable air superiority fighter, preferably one able to interoperate with U.S. Air Force counterparts, will grow. Over time, should the U.S.-Japan alliance prove incapable of deterring PRC military action over a territorial dispute, an inability to defend against conventional MRBMs and GLCMs could prompt a future political leadership in Tokyo to rethink self-imposed restrictions on the development of offense strike systems. Past media reporting indicates Tokyo has at least considered the procurement of strike systems such Tomahawks.[140]

### India

While India and China maintain cordial official relations, tensions simmer under the surface. The PRC's territorial dispute with India is over two tracts of land in the northern and eastern India - Aksai Chin, which is currently administered by the PRC under Xinjiang Province; and Arunachal Pradesh, which is currently administered by India. While competing claims are unlikely to erupt in conflict, it is worth noting that the Sino-Indian war of 1962 has severely conditioned Indian threat perceptions of China. For all the PRC's attempts to resolve border disputes with its neighbors, the one with India is still outstanding. India is enhancing its aerospace power with significant investment into Air Force, theater missile, and missile defense modernization.[141]

With declared security interests extending from the Persian Gulf to the Strait of Malacca, the Indian Air Force (IAF) is rapidly modernizing to meet the country's security interests. The IAF is in the process of upgrading its older fleet of Russian MiG-21, MiG-27, and MiG-29 fighters as well as its Jaguar and Mirage airframes. IAF Su-30MKI strike fighters are at the core to its deep strike capabilities. A large portion of its existing fleet of around 500 fighters consists of older MiG-21 airframes. Under its Medium Multi Role Combat Aircraft (MMRCA) program, the IAF intends to procure up to 126 new fighters from any one of a number of contenders, including the Eurofighter, F-16C/D, and Russian MiG-35.

Among the IAF's five operational commands, the Western Air Command, located at Subroto Park in New Delhi, is viewed as the most likely to be involved in any future air campaign related to Aksai Chin. For the flashpoint of Arunachal Pradesh, the IAF's Eastern Air Command, headquartered in Shillong, would bear the brunt of a campaign. Shillong is located less than 1000 kilometers from DF-21 brigades in Chuxiong, and within 1800 kilometers of GLCM garrisons in Liuzhou and Guiyang.

In response to Chinese and Pakistani theater missile development programs, India's Defence Research and Development Organization (DRDO) has been diversifying the Indian Army's ballistic and land attack cruise missile inventory. India's conventional and nuclear-capable solid-fueled, road mobile ballistic missile force is comprised of the Agni-I SRBM, with a range of more than 700

kilometers, the Agni-II MRBM, with a range of at least 1,500 kilometers, and the Agni-III intermediate range ballistic missile (IRBM), with a range of 3,000 kilometers or more.[142]

The Agni-I, primarily oriented toward Pakistani contingencies, was first tested in 1989. The Agni-II is currently in operation in the Indian armed forces, and the Agni-III is currently thought to be in the process of induction into the armed forces after its latest successful February 7, 2010 test.[143] Flight testing of an extended range variant of the Agni-III – the 5,000 kilometer range Agni-V – is expected before February 2011.[144] Indian Institute of Science engineers reported in 2008 the successful development of a new coating that reduces drag on a re-entry vehicle, thus increasing the potential range of ballistic missiles by as much as a third.[145] The DRDO is also reportedly developing a 1,000 kilometer range GLCM known as the Nirbhay.[146]

India is also developing a multi-layered integrated air and missile defense system that encompasses a space segment, as well as terminal and mid-course missile defense systems. India expects to deploy the initial missile defense coverage against MRBM and IRBM threats by 2012.[147] Seeking to eventually be able to engage ICBM threats with a range of greater than 5,500 kilometers, three tests of its mid-course interceptor were conducted between 2006 and 2009.[148] Mountain-based long range early warning radars, including two advanced missile defense early warning and fire control radar systems reportedly acquired from Israel in 2001, are expected to provide cueing for its missile defense interceptors.[149] In addition, India's space authorities have expressed interest in space-based missile warning systems.[150]

In short, India is rapidly expanding its ballistic missile and LACM capabilities, augmented by indigenous missile defenses, as well as modernizing its conventional air forces. Reflecting a growing confidence in its missile capabilities, DRDO director V.K. Saraswat reportedly commented that "after Agni III and Agni V, as far as cities in China and Pakistan are concerned, there will be no target that we want to hit but can't hit." Shrugging off the notion of a strategic rivalry, one PLA National Defense University professor concludes that India is still 10 to 15 years behind China in terms of missile technology.[151]

# PRC Aerospace Modernization and Regional Stability

The Asia-Pacific region is in the midst of fundamental change, with significant implications for long term strategic stability. The gradual expansion of China's long range precision strike capabilities, especially its increasingly sophisticated conventional ballistic missiles and GLCM infrastructure, is altering the regional strategic landscape. Due their speed, precision, and difficulties in fielding viable defenses, these systems – if deployed in sufficient numbers – have the potential to provide the PRC with a decisive military edge in the event of conflict over territorial or sovereignty claims. Reliance on ballistic missiles and extended range LACMs also incentivizes other militaries to develop similar capabilities. Beyond force modernization programs in India and Taiwan, the PRC's expansion of its aerospace capabilities is at least a partial driver for a modest shift in U.S. defense policies.[152]

The PLA's expanding capacity to deny the United States access to bases and the ability to project power into the region figured prominently in the 2010 Quadrennial Defense Review (QDR):

> *U.S. forces must be able to deter, defend against, and defeat aggression by potentially hostile nation-states. This capability is fundamental to the nation's ability to protect its interests and to provide security in key regions. Anti-access strategies seek to deny outside countries the ability to project power into a region, thereby allowing aggression or other destabilizing actions to be conducted by the anti-access power. Without dominant U.S. capabilities to project power, the integrity of U.S. alliances and security partnerships could be called into question, reducing U.S. security and influence and increasing the possibility of conflict.*[153]

Highlighting the PRC's MRBM, LACM, submarine, electronic warfare, long range air defense, and fighter development, the report stresses the need for a joint air-sea battle concept to defeat anti-access and area denial capabilities. It also promotes developing long range strike capabilities, strengthening the resilience of overseas bases, and ensuring access to space and use of space assets.[154]

The 2010 QDR outlines a number of options, including equipping future Virginia-class attack submarines for conventional strike missions. The Unmanned Combat Air System (UCAS) would permit strike operations to be conducted from carriers at ranges beyond that of an ASBM and other area denial capabilities. The U.S. Air Force is evaluating a number of systems for long range strike, and together with the Navy, is examining alternatives for new joint cruise missile programs. Conventional prompt global strike prototypes are also under evaluation.[155]

Augmenting the QDR are a number of analyses outlining ways to manage the dynamic shifts underway in the region. With concerns rising over the anti-access challenge to utilizing bases in the

Western Pacific and area denial capabilities that could restrict U.S. naval operations, pressure to reduce the U.S. footprint in Japan and elsewhere could mount. Noting the emergence of an arms race, the Center for a New American Security's Robert Kaplan foresees U.S. bases moving away from allied territories to Guam and the South Pacific Islands, and greater U.S. naval presence in the Indian Ocean.[156]

To counter the PLA's growing capacity to carry out an extended range aerospace campaign, one detailed study suggests investing in the ability to withstand initial strikes and limit damage to U.S. and allied forces and bases, neutralize PLA command and control networks, suppress the PLA's theater sensor architecture and theater strike systems, and sustain initiative in the air, on the sea, in space, and within the cyber domain.[157] Another study outlines the operational advantages and challenges of forward based conventional ballistic missiles and other prompt global strike systems launched from U.S. bases in Japan or Guam and the need for survivability should a decision be made to do so.[158]

In sum, the PRC's expanding aerospace capabilities are influencing the development of similar capabilities in other defense establishments, including the United States. However, they may also have another effect. PLA successes in fielding advanced long range precision strike systems dilute international efforts to stem the proliferation of delivery platforms for weapons of mass destruction. This may encourage other countries to follow suit, especially as China's global leadership and standing increases. In light of Russia's threats of withdrawal from the Intermediate Nuclear Force (INF) Treaty, partially due to the global proliferation of short and medium range ballistic and ground launched cruise missiles, the PLA's selection of these systems to defend its territorial claims could also undermine one of the most successful and enduring arms control agreements to date.

# Conclusion

Largely driven by a Taiwan scenario, China's capacity to conduct a successful aerospace campaign for decisive air advantage is surpassing the defenses fielded by Taiwan, Japan, perhaps India, and even U.S. forces operating in the Western Pacific. Among the most significant capabilities that are contributing toward regional aerospace imbalances are the PLA's long range precision strike systems, primarily its conventional ballistic and land attack cruise missiles. Perhaps equally as important is an evolving sensor network to accurately cue these strike assets and offer situational awareness. Another factor is China's growing ability to defend its strike assets from interdiction on the ground and redundancy in its command and control system.

Over time, an expansion of its theater missile infrastructure, conventional air power, and sensor systems could give China a decisive edge in securing the skies around its periphery should territorial disputes erupt into conflict. The ability to dominate the airspace over a given geographic domain has the potential to create regional instability in the event of political disagreements. The more confident that a country is of military success, the greater the chance that force could be assertively applied in pursuit of political demands.

Over the next 15 years, the PRC may be increasingly confident of its ability to dominate the skies around its periphery in a region with limited persistent surveillance architecture. This may lead Beijing to become more assertive in its dealings with its neighbors. A strategic shift in regional aerospace balance also may increasingly unravel the fabric of U.S. alliances and prompt allies and friends to consider weapons of mass destruction and their means of delivery as an insurance against unfavorable imbalances.[159]

Addressing these challenges require maintaining or developing the means to undercut the political and military utility of the PRC's theater missile-centric strategy and striving for a balance that could deter PRC recourse to force or other means of coercion. However, alternative approaches could offer initiatives for moderating PLA force postures and address underlying security dilemmas through cooperative threat reduction programs.

## Taiwan as the Testbed

Rolling back the missile problem starts with Taiwan. The potential for PRC coercive use of force to resolve political differences with Taiwan has been, and likely will remain, the primary flash point in the region. It is also the contingency that most likely would bring the U.S. and China, as well as others in the region, into armed conflict. With the aforementioned in mind, a relative erosion of Taiwan's military capabilities could create opportunities and incentives for Beijing's political and

military leadership to assume greater risk in cross-Strait relations, including resorting to force to resolve political differences.

Beijing's goal in assured air superiority through theater missiles is conceived as defensive in nature. Spurred by long standing insecurities, the PRC seeks to suppress the ability of a potential adversary to conduct strikes against its territory through a combination of traditional air defenses and long range precision strikes wherever they may originate. However, Beijing's goals are not simply defensive in nature. In order to deter perceived moves toward *de jure* independence, the PRC also seeks the capacity to dominate the skies over Taiwan, whether as part of an integrated coercive air campaign, a maritime blockade or physical occupation, or simply to exercise sovereignty over the skies of Taiwan.

The focus on Taiwan is the product of numerous interests. The Taiwan independence "threat" conveniently justifies PLA budget increases in a resource- constrained bureaucratic environment. It also provides a pretext for accelerating modernization without raising excessive alarm from others in the region. As the unresolved cross-Strait status stands as an issue that captures wide bureaucratic and public support, it is also useful in validating the development of capabilities applicable to other contingencies around China's periphery.[160]

U.S. policy should adopt a mix of positive and negative incentives to garner Beijing's commitment to peaceful means of resolving political differences with Taiwan and reduce the PLA's force posture opposite the island, particularly its SRBM deployment.[161] Barring such a shift in PRC's defense policy, undercutting the political and military utility of PLA aerospace power is a viable approach for Taiwan. Because passive and terminal missile defenses, such as PATRIOT PAC-3, alone are insufficient to undercut the coercive and military utility of the PRC's ballistic missile and land attack cruise missiles, Taiwan's reported program to field the Hsiungfeng-2E indigenous LACM is not without reason. Beyond this, incentives should be developed to reduce PRC confidence in the political and military utility of its theater missile-centric strategy. Taiwan's increased investment into passive defenses could mitigate the effects of China's growing prowess according to a solid assessment of Taiwan's unique operating environment.[162]

A second track could be to begin assessing options for a multi-role fighter able to operate from shorter runways. A variety of options are worth considering, including the eventual release of F-35B, the transfer of an existing VSTOL design, such as the AV-8B, or the initiation of design work on a VSTOL-capable advanced indigenous defense fighter.

The third and most politically sensitive track would be the principled release of additional F-16s to Taiwan as an interim bridge to fielding of a VSTOL airframe. Release of additional F-16s would be an appropriate and measured response to the PRC's growing reliance on ballistic missiles as an instrument of coercion. Should Beijing demonstrate clear intent to redeploy or drawdown its five confirmed SRBM brigades opposite Taiwan, then formal notification to Congress could be deferred. Such an approach constitutes a form of reciprocal unilateralism. However, explicit negotiations

linking PRC ballistic missile deployments with U.S. arms sales to Taiwan would be neither appropriate nor desirable.[163]

Yet, the PRC has long linked U.S. arms sales to Taiwan with ballistic missiles. The first linkage concerns the initial release of 150 F-16 A/B fighters to Taiwan in 1992 and subsequent sale of 300 kilometer range M-11 SRBMs to Pakistan.[164] As then-RAND scholar Evan Medeiros argued in a classic treatise on Chinese non-proliferation policies, "the F-16 sales quickly and fundamentally changed the nature of U.S-China negotiations on missile non-proliferation." Beijing also has leveraged prospects of missile-related transfers to Iran as a means to reduce U.S. arms sales to Taiwan.[165]

Beijing has long viewed U.S. arms sales to Taiwan in a predominately political context. Yet, the United States, and Taiwan to a lesser extent, has approached arms sales issues from a primarily military perspective. From Beijing's perspective, the military value of F-16s and Taiwan's other legitimate defense requirements are less relevant than their political implications. The PRC presumes that arms sales will stoke Taiwanese "independence" sentiments and encourage Taipei to negotiate on terms less favorable to Beijing. In the case of the latter, the Ma administration has linked the removal of the SRBMs opposite Taiwan with the initiation of political negotiations.[166]

The single most significant act that could be taken to avoid risks of military confrontation over the next 10 to 15 years would be a PRC renunciation of military force to resolve its political differences with Taiwan. This, in conjunction with a tangible reduction in its military posture, specifically a drawdown or even redeployment of the SRBM infrastructure deployed opposite Taiwan, would facilitate demilitarization in the Taiwan Strait and set the region on a more stable course.

In the near term, a PRC withdrawal of its five SRBM brigades opposite Taiwan would demonstrate peaceful intent and enhance stability in the Asia-Pacific region. While unconfirmed reports have indicated that the issue is under consideration in Beijing, withdrawal of missiles alone would be insufficient.[167] Operationally, removing the missiles themselves would only involve redeployment of the regiment under 52 Base which stores the SRBMs (the 96176 Unit). In the future, any redeployment of the infrastructure under 52 Base (consisting of five SRBM brigades opposite Taiwan) to 53 Base, 55 Base, or 56 Base would increase warning time and thus build confidence.

## A Global INF?

China's conventional ballistic missile and GLCM build-up has taken place within the vacuum created by the INF Treaty. The treaty, signed in December 1987, had called for the elimination of all U.S. and Russian land-based ballistic and cruise missiles, ranging 500 to 5,500 kilometers, within three years. The agreement was unlimited in its geographic coverage but did not include air- and sea-launched missiles. By May 1991, the United States and Soviet Union had dismantled the last of more than 2,500 GLCMs and ground-launched ballistic missiles along with their support equipment as covered under the INF Treaty.

A unilateral Chinese withdrawal of its SRBM infrastructure would be a good starting point toward a parallel initiative. The PRC's emphasis on ballistic missiles and LACMs provides an impetus for others to develop similar capabilities. Therefore, another track to augment U.S. and allied force modernization programs could be part of a broader effort to globally roll back land based ballistic and cruise missiles. Chinese restraint in the development, production, and deployment of extended range land based conventional ballistic and cruise missiles would also build confidence among its neighbors and reduce incentives to develop and field countermeasures.

Calls for global restrictions on land based theater missiles are not new. In part due to China's build up of theater missiles, Russia has outlined concerns regarding the strictly bilateral nature of the INF Treaty. This has been echoed by others who have advocated a global "zero ballistic missile (ZBM) regime" and flight test ban.[168] Washington and Moscow have sought to strengthen the INF Treaty by encouraging other countries to join the accord. In October 2007, Russian President Vladimir Putin told then-Secretary of State Condoleezza Rice and Secretary of Defense Robert Gates that his government would find it difficult to continue complying with the INF Treaty unless it was also ratified by other countries. During a United Nations General Assembly session, both Russia and the US issued a statement:

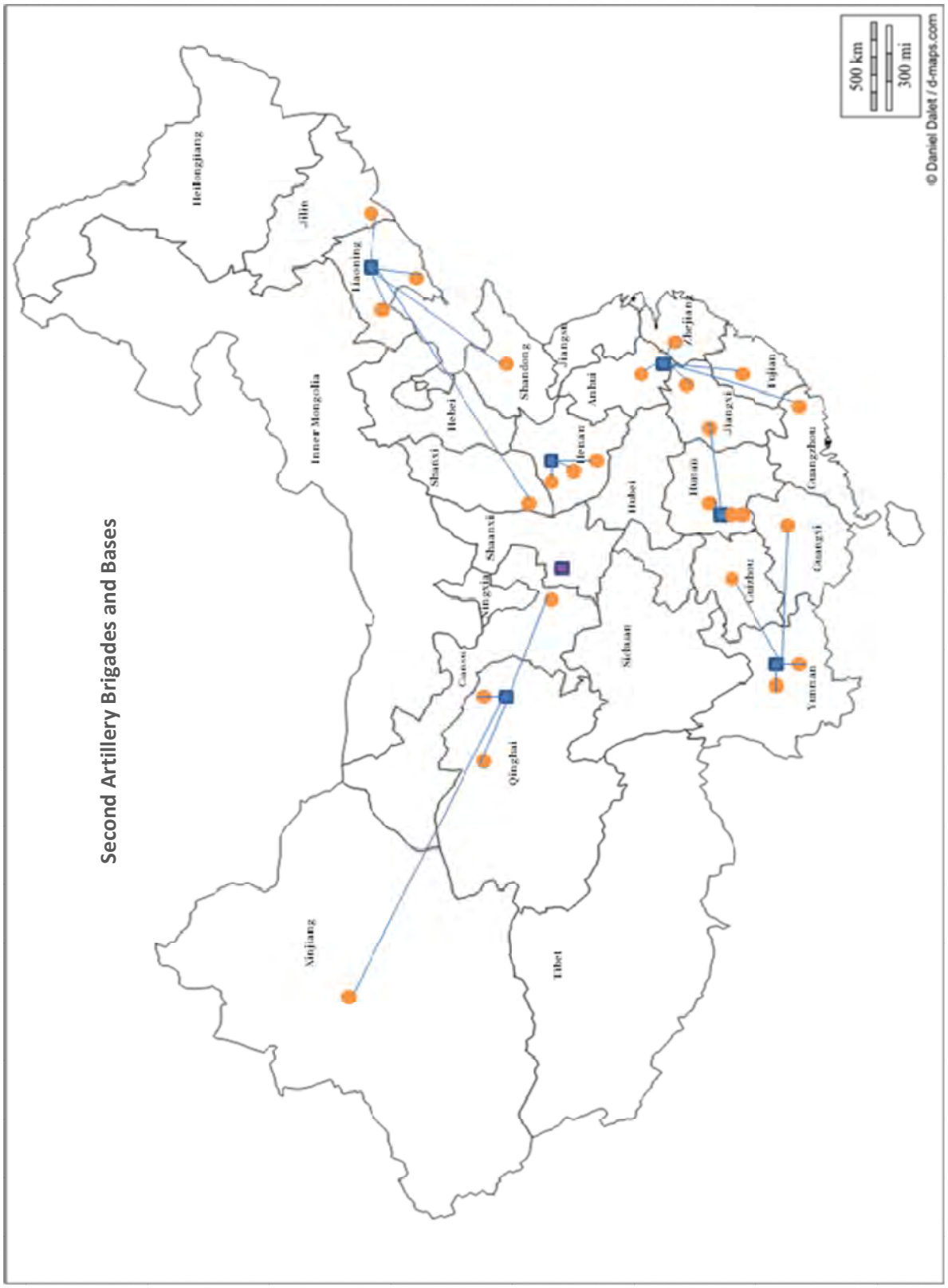
> *"The Russian Federation and the United States call on all interested countries to discuss the possibility of imparting a global character to this important regime through the renunciation of ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 kilometers, leading to the destruction of any such missiles, and the cessation of associated programs. Such a renunciation would serve to strengthen the international nuclear missile nonproliferation effort."*[169]

A global ban on land based theater missiles would stabilize the regional security environment by reversing current trends and encouraging an environment in which air assets would be the predominant strike asset. An air-centric environment would increase warning times, boost the relative utility of air defenses, and promote greater stability in times of crisis. Restrictions on theater missiles would also decrease the chances of accidental launches of nuclear-capable ICBMs and submarine-launched ballistic missiles.

How PRC aerospace-related capabilities will evolve over the next 15 years is still unclear, particularly in relation to the capabilities of the United States and Taiwan, as well as U.S. allies and friends such as Japan, Republic of Korea, Australia, and India. Over time, the same capabilities arrayed against Taiwan could be brought to bear in the pursuit of other sovereignty claims around its periphery. The size and form of the Second Artillery's extended range ballistic and ground launch cruise missile infrastructure could also be a metric of intent toward others in the future.

An international or regional agreement to restrict land-based theater missiles is worth considering as under-preparedness could prove to be detrimental to long term U.S. interests. Developments to watch closely include improvements in the range and payload of PLA aircraft; increases in the

lethality, accuracy, and numbers of PLA conventional ballistic and land attack cruise missiles; and an expansion of China's regional persistent surveillance network. These indicators have profound strategic implications for the U.S. and given the centrality of the Asia-Pacific to U.S. global interests, China's aerospace development certainly warrants further attention.


Second Artillery Brigades and Bases
500 km
300 mi
© Daniel Dalet / d-maps.com
Heilongjiang
Jilin
Liaoning
Inner Mongolia
Hebei
Shandong
Jiangsu
Anhui
Zhejiang
Fujian
Shanxi
Henan
Hubei
Hunan
Jiangxi
Guangzhou
Guangxi
Shaanxi
Qinghai
Sichuan
Guizhou
Yunnan
Xinjiang
Tibet

*Blank Page*

## References:

[1] Richard C. Bush III, "China and the U.S.-Japan Alliance," *Yomiuri Shimbun*, June 6, 2009, at http://www.brookings.edu/opinions/2009/0606_china_japan_bush.aspx, accessed on December 8, 2009.

[2] Among various sources, see Aaron L. Friedberg, "The Future of U.S.-China Relations: Is Conflict Inevitable?," *International Security*, Vol. 30, No. 2 (Fall 2005), pp. 7–45, at http://belfercenter.ksg.harvard.edu/files/is3002_pp007-045_friedberg.pdf, accessed on February 20, 2009.

[3] For the purposes of this paper, a theater missile is a ballistic or cruise missile with a range of between 500 and 5500 kilometers.

[4] *Department of Defense Dictionary of Military and Associated Terms* (Joint Publication 1-02), June 13, 2007, p. 27. Also see Clayton Chun, *Aerospace Power in the 21st Century: A Primer* (Colorado Springs, CO, 2001), pp. 1-39.

[5] John A. Warden, *The Air Campaign: Planning for Combat* (Washington DC: National Defense University Press, 1988), pp. 13-24.

[6] See, for example, John A. Warden, "The Enemy as a System," *Airpower Journal*, Spring 1995, pp. 40-45.

[7] Warden, *The Air Campaign: Planning for Combat, p. 26.*

[8] *China's National Defense in 2008* (Beijing: Information Office of the State Council of the People's Republic of China, January 2009), at http://www.gov.cn/english/official/2009-01/20/content_1210227_4.htm, accessed on May 3, 2010.

[9] For a detailed account of China's aerospace campaign doctrine, see Mark Stokes, "The Chinese Joint Aerospace Campaign: Strategy, Doctrine, and Force Modernization,'" in James Mulvenon and David Finkelstein (ed.), *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army* (Arlington, VA: CNA Corporation, 2005), at http://www.cna.org/documents/DoctrineBook.pdf, accessed on January 20, 2010.

[10] Limited firepower assets would be intended to use against targets whose destruction or suppression can achieve the greatest effects. Primary targets for the application of firepower include command and control systems and associated communications; strategic infrastructure; the most advanced capabilities of the opponent, including the air defense system; defense industries; and airbases and ports. From the PLA's perspective, air and conventional theater missile strikes are the most important means of firepower against deep targets.

[11] Patrick E. Tyler**,** "As China Threatens Taiwan, It Makes Sure U.S. Listens," *New York Times*, January 25, 1996.

[12] Mark Stokes, "China's Nuclear Warhead Storage and Handling System," *Project 2049 Occasional Paper*, March, 2010, p. 3

[13] According to a former engineer, the 96637 Unit is located in Kangzhuang. Formerly known as the 80809 Imagery Group [80809部队图像队], the unit shifted its mission toward operations support in 2002. In addition to providing imagery for land attack cruise missile brigades, the unit is also said to carry out electronic reconnaissance, translation, and, in a crisis, battle damage assessment in direct support of strike operations. See, for example, Liu Feng and Wang Bingjun, "Second Artillery 96637 Unit Establishes 'Warrior Culture'" [第二炮兵96637部队营造"尚武"文化], *Worker's Daily*, August 3, 2006, at http://news.sina.com.cn/c/2006-08-03/01009640261s.shtml, accessed on 20 February, 2010. The Second Artillery's central logistics depot [96628 Unit] is the Second Artillery Logistics Department's primary depot [某综合仓库] for non-mission essential materials and components, and is located in the same area.

[14] The primary Second Artillery ECM Regiment is the 96620 Unit, home-based in Dingxing and commanded by Col Li Changwei [李长伟]. A newer regiment (96634 Unit) appears to have been formed in Nanchang.

[15] Among various sources, see "Experience in Personnel Education in the Second Artillery Logistics Department Integrated Depot" [第二炮兵后勤部某综合仓库育人经验谈], *China Youth Daily*, November 30, 2000, at http://www.chinayouthdaily.com.cn/gb/djysd/2000-11/30/content_120940.htm, accessed on May 4, 2010.

[16] "Second Artillery Engineering Academy Produces 88% of Brigade Commanders, *PLA Daily*, October 20, 2009, at http://mil.news.sina.com.cn/2009-10-20/0723570658.html, accessed on April 20, 2010.

[17] China's aerospace R&D strategy is guided by a concept known as "Three Moves in a Chess Game" [*sanbuqi;* 三步棋]. It calls for three variants of a particular system to be in the R&D cycle at any one time. Under this concept, the variants should be in three increasingly advanced stages of R&D: 1) preliminary research [*yuxian yanjiu*; 预先研究 or *yuyan;* 预研]; 2) model R&D [*xinghao yanzhi;* 型号研制] involving design, development, testing, design reviews, and then "freezing" or finalization of the design (*dingxing*; 定型); and 3) low rate initial production. "Commemorating the Birthday of Marshal Nie Rongzhen and the Founding of the Aerospace Industry," *Xinhua*, November 20, 2009, at http://zt.xinhua023.com/2009/yrz110/2009-11/20/content_429123.htm, accessed on December 20, 2009.

[18] See "Report on Second Artillery Representative Offices" [来自二炮军代室的报告], *PLA Daily*, April 25, 2001, at http://health.eastday.com/epublish/gb/paper200/1/class020000007/hwz274633.htm, accessed on May 12, 2010. The Second Artillery's Equipment Research Academy and research labs within the Second Artillery's Engineering Academy support Second Artillery headquarters staff in the development of technical requirements documentation. For example, the Academy's Operations Support Department has produced a number of studies on anti-ship ballistic and anti-satellite technologies. Authors of articles on ASBM and ASAT requirements include Tan Shoulin [谭守林], Wang Minghai [王明海], Li Xinqi [李新其], Zhang Daqiao [张大巧], and Tang Baoguo [唐保国]. Most are affiliated with the Engineering Academy's 603th Instruction and Research Lab [603 教研室]. The Department of Automated Control's 303 Lab [二炮工程学院303教研室] has performed technical analysis on near space flight vehicles.

[19] One unit under the Nanjing Military Region in the area of Xianyou (73661 Unit) and one in the area of Puning, Guangdong Province (75810 Unit).

[20] Among various sources, see John Wilson Lewis and Hua Di, "China's Ballistic Missile Programs: Technologies, Strategies, and Goals," *International Security*, Fall 1992, pp. 5-40. A knowledgeable Chinese source familiar with the missile's history asserts that DF-15 was first flight tested in June 1988, and its design certified in early 1990.

[21] Lewis and Hua, "China's Ballistic Missile Programs: Technologies, Strategies, Goals," pp. 5-25.

[22] The chief designer of the DF-11 was Wang Zhenhua, from the 066 Base Design Department. A deputy designer on the DF-11 program, Liu Shiquan, led the design efforts on the DF-11A. See "Liu Shiquan: Placing National Interests and People's Interests Above All Else" [刘石泉：国家利益、民族利益高于一切], *Xinhua Network*, October 12, 2007, at http://www.hb.xinhuanet.com/interview/2007-10/12/content_11380291.htm, accessed on May 5, 2010. For background on various technical characteristics, see Mark Stokes, "Weapons of Precise Destruction: PLA Space and Theater Missile Development," in *China and Weapons of Mass Destruction: Implications for the United States*, National Intelligence Council Conference Report 5 (2000), at http://www.dni.gov/nic/confreports_chinawmd.html#Link3.

[23] See Zhang Xiaozhong (ed), *Sharpening the Spear, Molding the Spirit* [lijian zhuhun; 砺剑铸魂] (Beijing: PLA Cultural Publishing, 2004); and Zhang Yanping, Zhang Xuan Jie, and Li Guoli, "Life in the Missile Business – Yang Yegong in the Eyes of His Comrades" [把生命融入导弹事业——战友眼中的杨业功], Xinhua, July 28, 2005, at http://www.cgw.cn/html/news/7/2009/0326/25654.shtml, accessed on March 10, 2010. In addition to Gao Jin, other seed unit members included Liao Yaojun, Sun Jinming, Zhou Xiaolin, Li Tian, Xia Xiaoping, Ye Naijun, Shi Xiangyang, and Lin Lixin just to name a few. Initial operational training with live fire testing was conducted over a 45 day period. Major General Gao Jin now commands 52 Base in Huangshan, the overarching organization overseeing the five (or six) SRBM brigades opposite Taiwan. Highly respected among his leaders, peers, and subordinates, MG Yang Yegong passed away in 1995.

[24] Battalions and companies are often referred to as a *fendui* (分队) and have an assigned number.

[25] For an excellent overview of Second Artillery organization, see Kenneth Allen and Maryanne Kivlehan-Wise, "Implementing the Second Artillery's Doctrinal Reforms," in James Mulvenon and David Finkelstein, ed., *China's Revolution in Doctrinal Affairs* (Alexandria, VA: Center for Naval Analysis, 2005). The 6-2 organizational structure is relatively new.

[26] The regiment, referred to as a "Missile Component Depot" [导弹器材仓库], is designated as the 96176 Unit. See Mark Stokes, *China's Nuclear Warhead Storage and Handling System*, *Project 2049 Occasional Paper*, March, 2010; and Su Haibin, "Focus on High Safety Standards for Subordinate Fuel Storage Support Units," *Studies on Basic Political Work*, December 2008, p. 65, at http://www.cqvip.com/qk/81771X/200812/28752572.html, accessed on January 20, 2010. Su is from the 96176 Unit. Also see "Civil-Military Team Building Units Pays a Visit"

[军民共建单位来我局走访慰问], Shangrao Municipal Tax Administration website, February 9, 2010, at www.jx-n-tax.gov.cn, accessed on February 20, 2010. According to a retired soldier previously assigned to the regiment, the Missile Component Depot has automated depot functions over the last few including installation of an enterprise resource management planning (ERP) system.

[27] Among various sources, see "Second Artillery Metrology Post Repairs 140 Missile Precision Devices Over Two Years" [二炮计量站2年维修140余台现役导弹瞄准设备], *PLA Daily*, March 7, 2010, at http://mil.news.sina.com.cn/2010-03-07/1240586122.html, accessed on May 16, 2010.

[28] See, for example, "Missile Brigade Commander" [导弹旅长], *Guangming Daily*, September 4, 2007, at http://www.gmw.cn/content/2007-09/04/content_665343.htm, accessed on January 3, 2010.

[29] The Vanguard Missile Launch Battalion [导弹发射先锋营] is cited in a 2005 reference as being a training unit subordinate to the 52 Base Missile Component Depot (96176 Unit). However, the last two numbers are probably transposed (should be 96767 Unit). See "Yong'an City to Host Advanced Local Military Work Report" [永安市举办先进性军地互学报告会], Sanming City government website, March 28, 2005, at http://www.sm.gov.cn/ggkf/showmessage.asp?id=2376&lm=%C8%AB%CA%D0%B6%AF%CC%AC, accessed on March 1, 2010.

[30] The first Meizhou brigade commander, Chen Chuhua [陈楚华], rotated for a tour as chief of staff of 22 Base (Second Artillery's central nuclear warhead storage base), then was promoted to major general and assumed the position of 52 Base deputy commander in 2008.

[31] See, for example, "PLA 96162 Unit Supports Residents in Freeze Disaster Relief Operations" [**中国人民解放**军96162**部**队 -**全力支援**驻地抗冰救**灾**], *Ganzhou Daily*, June 2, 2008, at http://www.gndaily.com/NEWS/2008-2/200826100122.htm, accessed on February 19, 2010.

[32] See "New PLA DF-11A Missile Brigade Valiantly Appears on Stage" [我军二炮新型DF-11A导弹旅首次强悍亮相], *Renminwang*, February 17, 2009, at http://news.qq.com/a/20090217/000734.htm, accessed on May 10, 2010; and Chen Shoufu et.al., "Second Artillery New Recruit Battalion in Spring" [二炮某部新兵营中处处春], *Zhongguang Network*, February 12, 2010, at http://www.cnr.cn/junshi/zgjd/ep/201002/t20100212_506021169.html, accessed on February 15, 2010. In addition to Col Zhang Jianqiang [张建强], the Deputy Commander is Yang Xiawen [杨夏文]. The Political Commissar [旅政委] is Xu Guoming [徐国明], who replaced Zhang Fengzhong [张凤中]. Headquartered in Jinhua's Wucheng District, the brigade's six battalions reportedly operate in the area of Luodian Village and Lishui City.

[33] ECM and ISR elements from the brigades participated in the exercise as well. "Second Artillery and Air Force Conduct Joint Live Fire Exercise for First Time" [**二炮与空**军首次进行实兵实弹导空联合演习], *Xinhua*, July 19, 2009, at http://war.news.163.com/09/0719/13/5EJBGC2P00011MTO.html, accessed on May 16, 2010.

[34] See Lewis and Hua, "China's Ballistic Missile Programs: Technologies, Strategies, and Goals," p. 28. The initial regimental-level DF-21 seed unit was established in Tonghua and was eventually upgraded to full brigade status. The DF-21A has used the 1.4 meter diameter FG-05C solid rocket motor, while the FG-05D variant was developed for use on the KT-1, KT-409 (probable ASAT vehicle), and probably the DF-21C. As an aside, the 2 meter diameter FG-06 and FG-07 are the first and second stages on the DF-31. There are indications that a 1.7 meter solid rocket motor was developed for the KT-1B solid fueled launch vehicle.

[35] The mobile launcher is probably manufactured by the CASIC 699 Factory (Xinli Machinery Factory) in Beijing. Overseeing 4566 employees, the 307 Factory director is Yang Shaohua (杨少华), who also serves as the Fourth Academy's second deputy director. The CASC First Academy's 211 Factory, located in Beijing, also may play a role in manufacturing developing portions of the missile structure. The 211 Factory is known as the Capital Machinery Corporation.

[36] For an excellent overview, see "The DF-21 Series Medium Range Ballistic Missile," *KKTT Blog*, August 23, 2009, at http://liuqiankktt.blog.163.com/blog/static/121264211200972375114290/, accessed on March 30, 2010. The DF-21A extended the range of the original DF-21, and began to be deployed in the early 2000s. A single remaining DF-3A brigade is said to be deployed with the Jinzhou brigade (96113 Unit), near Dalian on the Liaoning peninsula. Subordinate elements are also reported to be located in the Ji'an area, near the North Korean border.

[37] For a detailed overview of the Pershing-2, see Huang Pinqiu, "Preliminary Analysis of Pershing-II Missile and Warhead" (*poxing-II daodan yu dantou de chubu fenxi*) *Missiles and Space Vehicles*, 1994(1). Huang was from the CASC First Academy's Beijing Institute of Special Electro-Mechanics, which is responsible for re-entry vehicle and warhead development.

[38] Citing a range of at least 1,750 kilometers, the 2009 DoD Report to Congress assessed that the PLA has 70-90 DF-21 MRBMs and 60-80 launchers in its inventory. The 2008 report assessed 60-80 missiles and 60 launchers, indicating that only 10 missiles are being added to the inventory each year. The 2007 report assessed 34-38 missiles and 40-50 launchers in the inventory.

[39] See "China Aerospace's 50-Year Sacred Journey: CASIC's Smelting of Its Strong Kaituozhe Spear" (中国航天50年巡礼: 科工四院 铸造长剑的坚强开拓者), *China Space News*, August 11, 2006. Also see http://www.dolc.de/forum/archiver/?tid-354991.html for further background. 688 mu is about 113 acres, 460,000 square meters, or 0.46 square kilometers. Chenguang's website claims the company's manufacturing space is now 720,000 square meters.

[40] The Laiwu brigade's chief of staff, Col Xu Zheng [绪政], led the DF-21C contingent during the Oct 09 parade.

[41] A Qingzhou city publication reported the visit of city officials to the 96119 Unit, in 2006. See "Qingzhou Record," Qingzhou City Government, August 5, 2006, at http://www.qingzhou.gov.cn/QZ/qingzhoudashiji/dsj00607.htm, accessed on January 2, 2010. The new unit appears to be situated in the vicinity of vacated DF-3 training garrison.

[42] For a discussion of a Qimen brigade's participation in the combined arms exercise, dubbed "Sharp Spear 2009," see "Second Artillery Brigade Conducts 'Sharp Spear 2009' Combined Exercise" [二炮某导弹旅举行"砺剑-2009"实兵综合演习], *Zhongguang Network*, August 21, 2009, at http://211.89.225.4:82/gate/big5/www.cnr.cn/junshi/zgjd/ep/200908/t20090821_505439708.html, accessed on March 3, 2010. Sun Qibao and Liu Xuming are listed as commander and political commissar of the 96163 Unit in the PLA Directory of Personalities (October 2009). Sun Qibao formerly served as Chief of Staff of the Meizhou SRBM brigade.

[43] See Yu Xihong and Wu Jiang, "Elite Second Artillery Brigade on a Windy, Snowy Night," *China Military Network*, February 12, 2009, at http://www.wamcc.com/read/536937.html, accessed on 27 March 2010; and "Second Artillery Converts to Another New Missile in July This Year," *Sohu News*, October 17, 2006, at http://news.sohu.com/20061017/n245844569.shtml, accessed on April 20, 2010. Col Wang Xiaochu [汪晓初] was the unit's first commander when it was stood up in 2002, and he served at least up early 2009. Wang was assigned as commander after graduation from the Command Academy. His thesis, "Vehicle Transportation Assurance in High Altitude, Cold Regions," won accolades at the Command Academy. His replacement, Col Li Zhenglian [李正连], appears to have taken over the brigade after serving as Chief of Staff of the Ganzhou SRBM brigade (96162 Unit).

[44] A previous Vanguard battalion commander was Tang Guozhong [汤国忠], who is now the 96166 Unit Deputy Commander. Another reference cited the unit as receiving a new missile in "皖," another name for Anhui province, specifically in the Nanshan District [南山区].

[45] The 96166 brigade commander, Tang Qixing [唐其兴] previously served in the Yong'an brigade [96167 Unit], and likely was one of the original cadre that introduced the first SRBM into Second Artillery's operational inventory. He also commanded the 52 Base's transportation regiment (96172 Unit). See "Chizhou Technology Academy and PLA 96166 Unit Conduct Signing Ceremony on Mutual Support," Chizhou Technology Academy website, December 24, 2009, at http://www.ahedu.gov.cn/newscentre/show.jsp?id=MTc1MTgw, accessed on January 19, 2010.

[46] Reports indicate an association with the Qingyuan town of Yingde is just over 130 kilometers north of Guangzhou. Among various sources, see "96219 Unit's Wei Jirong: Use Knowledge to Advance Responsibility" [96219部队 韦继荣：用知识挑起责任], *China Military Network*, September 7, 2007, at http://www.chinamil.com.cn/site1/2007ztpdc/2007-09/07/content_943167.htm, accessed on April 21, 2010. For references to a presence in Qingyuan, see "Units in Qingyuan Visit Qingxin County Jintanzhen Red Star Elementary School" [驻清远部队慰问清新县浸潭红], Foshan City Government website, June 10, 2009, at http://www.fs.cn/xxgk/ztjs/gycs/gngy/200906/t20090615_1236192.htm, accessed on May 3, 2010.; and "Qingyuan Units Donate Books to Makou Bayi Hope Elementary School," *Qingyuan Network*, September 7, 2009, at http://www.syooy.com/HNnews-p24015.html, accessed on May 2, 2010. For references to a presence in Chuxiong,

see "Provincial People's Government of Yunnan Province on 2008 Social Collective Advancement," *Yunnan Provincial Government Announcement*, March 22, 2009, at http://www.yn.gov.cn/yunnan,china/72621643502977024/20090322/1188244.html, accessed on May 2, 2010. One article implies that as of September 2009, the brigade was still a seed unit without a missile and developing a simulation system for training. It tested the simulation system against a live missile launch in Northwest China in 2008. See Zhou Shangyu and Wei Cunren, "'Red Card' Can Gain Award: Second Artillery Brigade Uses Talented Youth to Develop Training Simulation System" [红牌牌"缘何能冲大奖--第二炮兵某旅启用年轻人才研制模拟训练装备纪实], *S&T Daily*, September 17, 2009, at http://www.stdaily.com/kjrb/content/2009-09/17/content_105292.htm, accessed on May 15, 2010. 96219 Unit Brigade Commander is Zhang Weiming [张卫民], Political Commissar is Chen Zhihao, Senior Engineer is Zeng Weidong [曾卫东], Equipment Department Director is Lu Kangwen [吕康文], and Li Shaogang is a battalion commander. Li was highlighted as a key member of a team to introduce a new missile.

[47] Sr Col Chen Guangjun [陈光军] has been identified as the Tonghua brigade (96115 Unit) commander. He was reported to have raised the brigade's readiness level after introducing a new system in 2002 for both conventional and nuclear missions, presumably referring to the DF-21C. Joining the brigade in May 2005, he was the first PhD graduate (Northwest Polytechnical University) to command a brigade. In 2006, three of his missile battalions were designated "First Class Training Battalions" [二炮兵军事训练一级营]. See http://military.china.com/zh_cn/top01/11053250/20080409/14774297.html.

[48] The new Delingha brigade replaced an established brigade that transitioned to the DF-31A and redeployed to Tianshui (the 96363 Unit). Some references indicate it is a training unit subordinate to 56 Base. However, the base's training regiment appears to be the 96371 Unit. Various sources include Hans M. Kristensen, "China Reorganizes Northern Nuclear Missile Launch Sites," Federation of American Scientists website, July 12, 2007, at http://www.fas.org/blog/ssp/2007/07/china_reorganizes_northern_nuc.php, accessed on January 21, 2010; Sean O'Connor's' "Dragon Fire: The Second Artillery Corps," IMINT and Analysis, at http://geimint.blogspot.com/2009/04/dragons-fire-plas-2nd-artillery-corps.html, accessed on March 8, 2010; and PLA Second Artillery Corps Order of Battle, *SinoDefense*, undated, at http://www.sinodefence.com/strategic/organisation/orbat.asp, accessed on March 8, 2010.

[49] For an overview of the DH-10 program, see Ian Easton, "Assassin Under the Radar," *Project 2049 Institute Futuregram,* September 2009. For a good overview of land attack cruise missile operational and proliferation challenges, see Dennis M. Gormley, "The Risks and Challenges of a Cruise Missile Tipping Point," *NTI Issue Brief*, September 2008, at http://www.nti.org/e_research/e3_missile_tipping_point.html, accessed on May 3, 2010. Also see Thomas G. Mahnken, "Cruise Missile Challenge Overview," *CSBA Backgrounder*, November 29, 2004, at http://www.csbaonline.org/4Publications/PubLibrary/B.20041109.CruiseMiss/B.20041109.CruiseMiss.pdf, accessed on May 3, 2010; and Richard Fisher, Jr, "China's New Strategic Cruise Missiles: From the Land, Sea and Air," June 3, 2005, International Assessment and Strategy Center, at http://www.strategycenter.net/research/pubID.71/pub_detail.asp, accessed on January 29, 2010.

[50] Peter Grier, "The Short, Happy Life of the Glick-Em," *Air Force Magazine*, July 2002, pp. 70-74.

[51] The CASIC Third Academy classifies cruise missiles as short range (50km or less), medium range (50 to 120km), medium-long range (120-500km), long range (500-5,000km), and very long range (5,000-8,000km), and intercontinental (above 8,000km). The DH-10 appears to rely on RP-3 aviation fuel, similar to U.S. J-10. See Li Liming [李立明], "Design of Central Missile Depot Support System for Certain New Missile" [某新型导弹中心库加注系统工艺设计], Conference Paper, China Space Association Launch Engineering and Ground Equipment Committee Meeting [中国宇航学会发射工程与地面设备专业委员会学术会议], 2003.

[52] The chief designer for the DH-10 has been the Third Academy Third Design Department's Liu Yongcai [刘永才]. See "Liu Yongcai: Embracing the Song of the Wind" [刘永才: 胸怀大爱唱大风], *China Space News*, January 26, 2010, at http://www.china-spacenews.com/n435777/n435778/n435788/65793.html, accessed on May 8, 2010. CASIC Deputy Director Xue Li oversaw testing. See [有功之臣亨受良好待遇], *China Space News*, August 1, 2003, at http://210.82.31.84:800/News/news_detail.asp?id=6594, accessed on May 8, 2010.

[53] Also known as the Beijing Xinghang Electro-Mechanical Equipment Factory, the 159 Factory

[54] The regimental-level DSMAC support function appears to be managed by the 96656 Unit. Its political commissar is Tao Xianfeng. See Zhang Wenping, "Tao Xianfeng: Striving to Developing 'Lead Goose'" [陶贤锋：争当科学发展'领头雁'], January 29, 2009, at http://www.allzg.com/n60372c201.aspx, accessed on April 30, 2010. Zhang Hong and Ma Yungang, "Special Characteristics and Digital Scene Matching Guidance and Discussion of Applications" [景象匹配制導特點及其應用分析探討], Proceedings of China Surveying and Mapping Institute Conference, 2009, at http://cpfd.cnki.com.cn/Article/CPFDTOTAL-CMJH200912001104.htm, accessed on March 20, 2010. Ma Yungang is an engineer with the 96656 Unit; and Zheng Yue et. al., "Design and Editing of High Precision Mapping Tools [高精度地 图符号编辑器 的设计 与实现], Journal of Zhengzhou Institute of Surveying and Mapping, December 2006, at www.lw23.com/pdf_1363d82c-b6b3-44ff-b191.../lunwen.pdf, accessed on May 3, 2010.

[55] The 2007 report said that first and second generation LACMs should be deployed "in the near future." The 2008 DoD Report to Congress on PRC Military Power noted that 50-250 LACMs and 20-30 launchers were deployed, and the 2009 report assessed that the PLA has 150-350 LACMs and 40-55 launchers in its inventory.

[56] The initial brigade commander appears to be Col Zhou Zhongchun [**周仲春**], who participated in flight testing. Also see "Ground Launched Cruise Missile Group Commander Gou Yi" [陆**基巡航**导弹**方**队长**苟翼**], *Xinhua*, October 1, 2009, at http://news.xinhuanet.com/mil/2009-10/01/content_12133327.htm, accessed on April 2, 2010. Also see "Taking the Spear into Battle" [**今日**长缨**在手**], *PLA Daily*, May 26, 2005 for an account of Zhou Zhongchun. For the concealment exercise, see "New Second Artillery Cruise Missile Exercises Twice to Avoid 'Satellites'" [**二炮新巡航**导弹**演**练**两次**躲**避**"侦**察**卫**星**" ], *China Youth Daily*, January 15, 2010, at http://news.xinhuanet.com/mil/2010-01/15/content_12813545.htm, accessed on January 17, 2010. The brigade commander referenced in the article, Col Xia Xiaoping, transferred to the Liuzhou LACM brigade from the Leping SRBM brigade in late 2009.

[57] The unit began to be equipped with LACMs in 2006. See "Second Artillery Successfully Test Fires 34 Cruise Missiles" [二炮参阅部队曾实弹试射34枚巡航导弹全部命中], *Xinhua*, October 13, 2009, at http://mil.eastday.com/m/20091013/u1a4721963.html, accessed on May 3, 2010; and "Second Artillery Officers and Men Bring Water to Disaster Relief Villages," *Zhongguang Network*, April 14, 2010, at http://www.cnr.cn/china/news/201004/t20100414_506280232.html, accessed on April 16, 2010.Noted as introducing a new missile, the brigade commander, Chen Degui, was cited as overseeing brigade air defense training in 2007. See Wei Cunren and Xu Yeqing, "Second Artillery Unit Promotes Guardianship and Improves Combat Effectiveness" [第二炮兵某部成建制换岗促战斗力提高], *PLA Daily*, March 14, 2007, at http://www.chinamil.com.cn/site1/xwpdxw/2007-03/15/content_763590.htm, accessed on March 23, 2010. Col Chen Degui [陈德贵] was first identified as the commander. Born in Chongqing in October 1964, Chen joined the army in 1982 and received his undergraduate degree from the Second Artillery Engineering Academy in 1986. He transferred to the Qingzhen brigade after serving as the Liuzhou brigade [96215 Unit] Chief of Staff in the 2003 timeframe. He previously had served in an unnamed warhead regiment. See, for example, "96217 Unit Visits Cultural Academy" [96217部队参观文化书院], China Cultural Academy website, March 27, 2009, at http://www.acc.gzu.edu.cn/go.asp?id=787, accessed on March 23, 2010.

[58] A contract announcement was issued in April 2010 for construction of facility for the 96217 Unit in Tianduzhen Wushi Village, in the eastern suburbs of the Sanya municipality. The agreement was signed in December 2008 and is expected to be completed by June 2011. See "PLA 96217 Unit Sanya Military Zone" [中国人民解放军96217部队三亚营区], PRC Ministry of Land and Resources website, April 1, 2010, at http://landchina.mlr.gov.cn/land/jggg/jghbgd/201004/t20100401_477663.htm, accessed on May 18, 2010.

[59] "Second Artillery Recently Established Missile Brigade Hits Target on High Plain" [二炮组建不久新型导弹旅赴高原打靶准确命中], *PLA Daily*, November 30, 2008, at http://news.ifeng.com/mil/2/detail_2008_11/30/475698_0.shtml, accessed on May 4, 2010. The commander, Col Li Youcheng [李友成], has been linked with the Yichun 96317 Unit. Also see "Zhao Qingyun: Discussion of Theatrical Performance for 96321, 96317 Units" [赵清云：在为驻县96321、96317部队进行慰问文艺演出上的讲话], Dongkou City Government website, at http://www.dkdj.gov.cn/Article/20060508102842.html, accessed on May 1, 2010.

[60] For detailed assessments of China's ASBM program, see Andrew Erickson and David Yang, "On the Verge of a Game-Changer: A Chinese Antiship Ballistic Missile Could Alter the Rules in the Pacific and Place U.S. Navy Carrier

Strike Groups in Jeopardy," *U.S. Naval Institute Proceedings,* Vol. 135, No. 3, (May 2009), pp. 26-32. Also see Andrew S. Erickson, "Chinese ASBM Development: Knowns and Unknowns," Jamestown Foundation *China Brief*, Vol. 9, Issue 13. For a broader summary, see Andrew S. Erickson and David D. Yang, "Using The Land To Control The Sea? Chinese Analysts Consider the Antiship Ballistic Missile," *Naval War College Review*, Autumn 2009, Vol. 62, No. 4, pp. 53-86. Also see Eric Hagt and Matthew Durnin, "China's Antiship Ballistic Missile: Developments and Missing Links," Naval War College Review, Autumn 2009, Vol. 62, No. 4, pp. 87-115; and Mark Stokes, "China's Evolving Conventional Strategic Strike Capability: the Anti-Ship Ballistic Missile Challenge to U.S. Maritime Operations in the Western Pacific and Beyond, *Occasional Paper*, (Arlington, VA: Project 2049 Institute, 14 September 2009).

[61] Statement of Admiral Robert F. Willard, U.S. Navy, Commander U.S. Pacific Command before the House Armed Services Committee on the U.S. Pacific Command Posture, March 23, 2010, at http://armedservices.house.gov/pdfs/FC032510/Willard_Testimony032510.pdf, accessed on April 14, 2010.

[62] In August 2009, the Hohhot city government announced the CASIC Sixth Academy's Honggang Factory (also known as the 359 Factory) completed a construction project for manufacturing of DF-21D solid rocket motors. See "Fifth Announcement of 2009 for Completion and Acceptance of Construction Projects for Environmental Protection" (关于2009年第五批建设项目环境保护设施竣工验收公众参与的公示 ), Hohhot City Government Environmental Protection Bureau, August 20, 2009, accessed on 30 August 2009. The facility is 1780 $m^2$.

[63] Possible candidates include one of the two brigades in the Chizhou area (96161 or 96166 Unit) or the new brigade currently in Chuxiong (96219 Unit), should it ultimately be destined for Guangdong.

[64] John Wilson Lewis and Xue Litai, "China's Search for a Modern Air Force," *International Security*, Vol. 24, No. 1, Summer 1999, pp. 64-94, at http://iis-db.stanford.edu/pubs/20614/China's_search_for_a_modern_air_force.pdf, accessed on March 20, 2010; Kevin M. Lanzit and Kenneth Allen, "Right-Sizing the PLA Air Force: New Operational Concepts Define a Smaller, More Capable Force," in Roy Kamphausen and Andrew Scobell (ed.), *Right Sizing The People's Liberation Army: Exploring The Contours of China's Military* (Carlisle, PA: US Army War College, 2007), pp. 437-478; Phillip C. Saunders and Erik Quam, "Future Force Structure of the Chinese Air Force in Roy Kamphausen and Andrew Scobell (ed.), *Right Sizing The People's Liberation Army: Exploring The Contours of China's Military* (Carlisle, PA: US Army War College, 2007), pp. 377-436; and Xiaoming Zhang and Sean D. McClung, "The Art of Military Discovery: Chinese Air and Space Power Implications for the USAF, *Strategic Studies Quarterly*, Spring 2010, pp. 36-62.

[65] The PLA Air Force and Second Artillery appear to have overlapping strategic strike missions. Stating that "the Air Force is a strategic service of the PLA, and the main force for carrying out air operations," the PRC's Defense White paper published in 2009 describes the PLA Air Force mission as "safeguarding the country's territorial air space and territorial sovereignty, and maintaining a stable air defense posture nationwide." The White Paper describes Second Artillery as "a strategic force under the direct command and control of the CMC, and the core force of China for strategic deterrence. It is mainly responsible for deterring other countries from using nuclear weapons against China, and for conducting nuclear counterattacks and precision strikes with conventional missiles." See *China's National Defense in 2008* (Beijing: State Council Information Office), January 20, 2009, at http://www.china.org.cn/government/whitepaper/node_7060059.htm, accessed on January 2, 2010.

[66] PLAAF goal is to gain local or limited air superiority, which permits freedom of flight over a limited area for a finite period of time. Limited air superiority is differentiated from theater air superiority, or supremacy, in which air assets can operate anywhere within the entire combat theater with impunity. See Liu Yalou, "New Historical Starting Point in the Modernizing the Air Force" [在新的历史起点上推进空军现代化建设], *Qiushi*, January 17, 2008, at http://www.chinavalue.net/Article/Archive/2008/9/18/135542.html, accessed on April 2, 2010. Also see *China's National Defense in 2008* (Beijing: State Council Information Office), January 20, 2009, at http://www.china.org.cn/government/whitepaper/node_7060059.htm, accessed on January 2, 2010.

[67] "General Xu Qiliang: The PLA Air Force will Develop an Integrated Air and Space Operational Capability" [许其亮上将：中国空军将发展空天一体作战能力], *Xinhua*, November 11, 2009, at http://mil.news.sina.com.cn/2009-11-05/1743572706.html, accessed on May 10, 2010.

[68] See Liu Yalou, "New Historical Starting Point in the Modernizing the Air Force"; Zhuang Jingqian, "Beijing Observation: Chinese Air Force Quickens Pace of Strategic Transition, Possibly by Taking Two Steps," *Zhongguo Tongxun She*, November 10, 2009, at http://www.haixiainfo.com.tw/print78917.html, accessed on May 17, 2010; "From Defense to Attack: Sixty Years of PLA Air Force Development," [从防御到进攻：中国空军的60年建设], Air

Force World, October 29, 2009, at http://news.ifeng.com/mil/special/kongjun60/lishi/200910/1029_8387_1410457.shtml, accessed on May 1, 2010.

[69] Among various sources, see Richard Fisher, "Chinese Chengdu J-10 Emerges," *Aviation Week*, January 14, 2010.

[70] See DoD Report to Congress, p. 50.

[71] Phillip Saunders and Eric R. Quam, "China's Air Force Modernization," *Joint Forces Quarterly*, Iss. 47, 4th Quarter, 2007, pp. 28-33.

[72] "Discussion with He Weirong: China Conducting R&D on Fourth Generation Aircraft" [对话何为荣：中国正在研制第四代战机], *Xinhua Network*, November 9, 2009, at http://news.xinhuanet.com/mil/2009-11/09/content_12416003.htm, accessed on March 2, 2010.

[73] China's leading figure in applied research in stealth is Dr. Wu Zhe [**武哲**]. An aircraft design specialist at Beijing University of Aeronautics and Astronautics (NUAA), Dr. Wu also serves as the PLA General Armaments Department S&T Committee's Stealth Technology Working Group [隐身技术专业组组长]. See, for example, "Changjiang University Alumni and Scholar Wu Zhe" [长江学者特聘教授武哲校友], Harbin Institute of Technology announcement, May 7, 2010, at http://90.hit.edu.cn/news/Showfc.asp?id=1827, accessed on May 10, 2010.

[74] Wang Changhe, "PLA Air Force 20 Year Review and Outlook" [中共空軍20 年的回顧與展望], in Li Chentong et. al., *The Philosophy of War and the Study on PRC's Strategy* [戰爭哲學與中共戰略研究] (Taipei: National Defense University War Academy, 2008), pp. 96-97.

[75] Zhang Youcai, "Denglu zhanyi dianzi duikang zuozhan zhidao de jige wenti" [Some questions surrounding ECM operational principles during a landing campaign], in *Zuozhan zhihui yanjiu* [Research on operational command and control], Beijing: NDU Press, January 1997, pp. 327-333. As of 1997, Major General Zhang Youcai was director of the GSD Fourth Department; also see Zhang Chenhui and Cai Shichuan, "Jianli denglu zhanyi dianzi duikang zhihui xitong de tantao" [Discussion on establishing an ECM command system during landing campaign], in *Zuozhan zhihui yanjiu*, pp. 342-347. Zhang and Cai are from the PLA Electronic Engineering Academy, the Fourth Department's primary entity responsible for ECM training and doctrine development. The Academy is located in Hefei, Anhui province. Zhang Youcai, pp. 327-333; Wang Yongsheng, "Denglu zuozhan kongzhong jingong zhanyi de dianzi jingong xingdong" [Electronic attack activity during the air attack campaign of a landing operation], in *Gaojishu tiaojianxia zuozhan zhihui yanjiu*, February 1996, pp. 361-365; and Cui Yansong, "Kongjun zuozhanzhong de xinxizhan qianshen" [Survey of information warfare in air force operations], in *Wojun xinxizhan wenti yanjiu* [Research on problems in PLA information warfare], Beijing: Guofang Daxue Chubanshe, 166-171. Senior Col Cui was Director, PLAAF HQ ECM Department.

[76] See, for example, Liu Zhiguo and Zhao Xinguo, "Research on Characteristics and Jamming Methods of JTIDS" [JTIDS链路特点及干扰方法初探], *Journal of the Academy of Equipment Command & Technology*, [装备指挥技术学院学报], Vol. 18 No. 1, (Feb 2007), pp. 79-82. Also see Wang Bangrong, Li Hui, Zhang An, and Zeng Wei, "Status quo and Future Development Trend of Tactical Data Links" [战术数据链的现状及未来发展趋势], *Fire Control and Command Control*, Vo1. 32, No. 12 (December 2007), pp. 5-9; and Lu, Yan Jiangang, and Fan Yan, "Anti-Jamming Performance Evaluation of Link-16 Tactical Data Link System and its Simulation" [Link-16战术数据链抗干扰性能评估与仿真], *Fire Control and Command Control*, Vol. 34, No. 2 (February 2009). For reference to use of high power microwave devices, see Wen Guangjun, Li Shigun, Guo Weili, Li Jiayin, and Li Lemin, "Study on the Possibility of Jamming JTIDS Signal with High Power Microwave Source" [高功率微波源干扰JTIDS信号的可能性分析], Journal Of Sichuan Institute Of Light Industry And Chemical Technology, 1999 19(3).

[77] Cui Yansong, "Kongjun zuozhanzhong de xinxizhan qianshen" [Survey of information warfare in air force operations], in *Wojun xinxizhan wenti yanjiu* [Research on problems in PLA information warfare], Beijing: Guofang Daxue Chubanshe, pp. 166-171.

[78] Li Hui, Yan Junwu, and Zeng Guiming, "Missile Defense Electronic Countermeasures Technology" [针对MD的电子对抗技术], *Missiles and Space Vehicles* [导弹与航天运载技术], 2007 Vol. 288, Iss. 2, pp. 58-61. The authors are from the China Academy of Launch Technology's First Design Department.

[79] Director of the Hainan GSD 4th Department ECM Regiment [61764 Unit] is Jin Guodong [靳国栋], as of 2009. One indication of the unit having satellite jamming responsibilities is the number of articles published by its members. See, for example, Li Bin and Jin Guodong, "Analysis on GPS Jamming" [浅析GPS干扰技术], *Electronic Countermeasures*, January 2009, pp. 39-42; Jin Guodong and Li Suoku, "On Broadband Communications Satellites" [宽带卫星通信探析], *Electro-Optical Systems*, April 2008, pp. 16-31; and Zhang Ming and Li Suoku, "Space Information Warfare and International Space Law" [空间信息作战与国际空间法], *Armament Command and Technology Academy Journal*, February 2003; and Xiang Hanfei, Li Suoku, and Han Honglin, "Analysis of GPS System Countermeasures" [GPS系统对抗若干分析], *Tracking and Communications*, October 2008.

[80] See Li Yiyong and Shen Huairong, "Key Technologies for Developing Near Space Flight Vehicles" [发展近空间飞行器系统的关键技术], *Journal of the Academy of Equipment Command & Technology*, October 2006, pp. 52-55.

[81] Guo Weimin, Si Wanbing, Gui Qishan, and He Jiafan, "Coordination and Applicability of Near Space Flight Vehicles in Missile Warfare" [导弹作战中临近空间飞行器与航天器的协同应用], *Winged Missiles* [飞航导弹], May 2008.

[82] Lt Col Ed "Mel" Tomme and Col Sigfred J. "Ziggy" Dahl, "Balloons in Today's Military? An Introduction to the Near-Space Concept," *Air & Space Power Journal,* Winter 2005. Also see Lt Col Edward B. Tomme, "The Paradigm Shift to Effects-Based Space: Near-Space as a Combat Space Effects Enabler," *Airpower Research Institute Research Paper,* 2005-01. For a general Chinese analysis, see Wang Shengkai, Quan Shouwen, Li Binhua, and Ma Qin, "Near Space and Near Space Flight Vehicles" (临近空间和临近空间飞行器), *CONMILIT*, (*Xiandai junshi*), 2007(7), pp. 36-39.

[83] For a representative Second Artillery overview, see Li Chao, Luo Chuanyong and Wang Hongli, "Research into Near Space Flight Vehicle Applications for the Second Artillery" [近空间飞行器在第二炮兵部队的应用研究], *Journal of Projectiles and Guidance*, January 2009; Tang Jiapeng, Guan Shixi, Ling Guilong, and Duan Na, "Study on Propulsion System of Near Space Vehicles," *Journal of Projectiles, Rockets, Missiles, and Guidance*, June 2009, pp. 145-148. Also see Li Zhen, Li Haiyang, and Yong En'mi, "Analysis of Trajectory Characteristics of Near Space Kinetic Weapons," *Journal of Projectiles, Rockets, Missiles, and Guidance*, June 2009, pp. 183-185.

[84] Wang Wenqin, Cai Jingye Cai, and Peng Qicong, "Conceptual Design Of Near-Space Synthetic Aperture Radar For High-Resolution And Wide-Swath Imaging," *Aerospace Science and Technology* (2009), pp. 1-8. Wang is from the University of Electronic Science and Technology of China (UESTC) and claims to be a leading advocate within China for near space SAR remote sensing.

[85] Near space vehicles are not without their challenges. Because the air is considerably less dense than at lower altitudes, near space vehicles require unique propulsion systems. Jet engines lose thrust as operating altitudes increase because the atmosphere is considerably less dense. Therefore, wing areas must be larger. Propeller-drive vehicles are an option, but they require large diameters or must be installed in large numbers. Exposure to ozone can be corrosive to some materials, and cosmic radiation can result in radiofrequency blackouts on occasion. See Major Andrew J. Knoedler (USAF), "Lowering the High Ground: Using Near-Space Vehicles for Persistent ISR," paper presented to Center for Strategy and Technology, Air War College, November 2005, p. 107.

[86] The 10th Research Institute is known as the Near Space Flight Vehicle Research Institute [临近空间飞行器研究所]. See Yang Jian, "CASC First Academy 10th Research Institute Established" (航天一院10所揭牌成立),*China Space News*, October 24, 2008 (in Chinese), at http://www.china-spacenews.com/n435777/n435778/n435783/49822.html; Zhan Shige and Meng Qingguo, "Conference Held in Beijing on Developmental Prospects for Near Space Flight Vehicles," *Bulletin of National Natural Science Foundation*, May 12, 2006, http://www.nsfc.gov.cn/Portal0/InfoModule_375/1111.htm.

[87] The establishment of a research institute and its place in the number scheme ("10th" Research Institute) within the CASC First Academy connotes the relative priority being placed on near space platforms.

[88] "A Certain CASC 7304 Factory Engine Moves into the High Altitude, Long Endurance Domain" [航天7304厂某发动机迈向无人机中高空长航时领域], *China Space News*, June 22, 2009.

[89] For examples of U.S. overviews of China's space modernization, see Andrew S.Erickson, "Eyes in the Sky," *U.S. Naval Institute Proceedings*, Vol. 136, No. 4 (April 2010), pp. 36-41; Gregory Kulacki and Jeffrey G. Lewis, *A Place for One's Mat: China's Space Program, 1956–2003* (Cambridge, MA: American Academy of Arts and Sciences, 2009), at

http://www.amacad.org/publications/spaceChina.pdf, accessed on April 16, 2010; Kevin Pollpeter, "The Chinese Vision of Space Military Operations," pp, 329-369, in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army*, edited by James Mulvenon and David Finklestein, CNA Corporation, Virginia. December 2005, at http://www.defensegroupinc.com/cira/pdf/doctrinebook_ch9.pdf, accessed on February 15, 2010; Larry M. Wortzel, *The Chinese People's Liberation Army and Space Warfare: Emerging United States-China Military Competition* (Washington DC: American Enterprise Institute, 2007), at http://www.aei.org/paper/26977, accessed on April 17, 2010; Dean Cheng "China's Space Program: Civilian, Commercial, and Military Aspects," CNA Corporation Conference Report, May 2006; Phillip C. Saunders, "China's Future in Space: Implications for U.S. Security," *AdAstra*, Spring 2005, pp. 21-23, at http://www.space.com/adastra/china_implications_0505.html, accessed on February 21, 2010; Eric Hagt and Matthew Durnin, "China's Antiship Ballistic Missile: Developments and Missing Links," *Naval War College Review* 62, No. 4 (Autumn 2009), pp. 87–115; and Joan Johnson-Freese, China's Space Ambitions, *IFRI Proliferation Paper*, Summer 2007, at www.ifri.org/downloads/China_Space_Johnson_Freese.pdf, accessed on April 20, 2010.

[90] For a good overview of this thesis, see Gregory Kulacki and Jeffrey G. Lewis, A *Place for One's Mat: China's Space Program, 1956–2003*, (Cambridge, MA: American Academy of Arts and Sciences, 2009).

[91] For one widely cited article published 10 years ago, see Ma Genhai, "Considerations Regarding China's Military Use Satellite System Entering the Next Century," *Journal of the Institute of Command and Control Technology* (*Zhihui jishu xueyuan xuebao*), 1999, Vol. 10, No. 6. Also see Zhu Bin and Chen Xuan, "A Space-Based Electronic Information System for Long Range Precision Strike," *Aerospace China*, 2007, Iss. 3.

[92] Qiu and Long assert that a program to deploy a space-based reconnaissance architecture, programmed under the 863 program for 2015-2020, was advanced in 2004. The total scope of the space architecture is unknown at the current time. However, in their 2006/7 *Modern Ships* article, Qiu and Long assess that during a crisis, 24 satellites could be available, including six EO satellites, 10 radar reconnaissance satellites, two maritime satellites, and six electronic reconnaissance satellites with a visit rate of 40 minutes. For emergencies, microsatellites, with a life of 1-2 weeks, can augment large ones and be launched from mobile platforms within 12 hours of an order.

[93] See Yuan Xiaokang, "Satellite Electronic Reconnaissance, Antijamming," *Shanghai Hangtian*, October 9, 1996, pp. 32-37, in *FBIS-CST*-97-011; and Yuan Xiaokang, "Some Problems of Space Electronic Reconnaissance," *Hangtian Dianzi Duikang*, March 1996, pp. 1-5, *CAMA*, Vol. 3, No. 4. Yuan is a key engineer involved space-based antenna systems design, including both ELINT and SAR, from the SAST 509th Research Institute (Shanghai Institute of Satellite Engineering).

[94] "China Blasts Off First Data Relay Satellite," *Xinhua News Agency*, April 26, 2008. For an example of the data relay satellite being used for missile guidance, see Chen Lihu, Wang Shilian, Zhang Eryang, "Modeling And Simulation Of Missile Satellite-Missile Link Channel In Flying-Control Data-Link" (基于卫星中继的导弹飞控数据链链路分析), *Systems Engineering And Electronics*, 29(6), 2007. The chief designer of the satellite was Ye Peijian (叶培建). Also see Wu Ting-yong, Wu Shi-qi, Ling Xiang, "A MEO Tracking and Data Relay Satellite System Constellation Scheme for China," *Journal of Electronic Science and Technology of China*, December 2005.

[95] See Sean O'Connor's excellent summary of the ASBM and OTH-B programs at http://geimint.blogspot.com/2008/11/oth-radar-and-asbm-threat.html.

[96] See Tang Xiaodong, Han Yunjie, and Zhou Wenyu, "Skywave Over the Horizon Backscatter Radar," 2001 CIE International Radar Conference Proceedings, January 2, 2001. Authors are from the Nanjing Research Institute of Electronic Technology. In a bi-static system, a typical transmitting site, however, can be about one-sixth the size of the receiver. Another type of OTH radar – a surface wave system -- also operates in the HF band, and relies on "electromagnetic coupling" of the HF waves to the sea surface. This coupling provides a means to detect targets over the horizon beyond the line-of-sight limit experienced by conventional microwave radar systems. Surface wave systems usually have a surveillance range no more than 400 km. Therefore, they are mostly used for local area defense against low-flying missiles and also for some monitoring of ship traffic. Surface wave radars are large and require sophisticated frequency management systems in order to operate via the ever-changing ionosphere.

[97] Xin Guo, Ni Jin-Lin, Liu Guo-Sui, "Ship Detection with Short Coherent Integration Time in Over-the-Horizon Radar," Conference Paper, International Conference on Radar (RADAR 2003), Adelaide, Australia on 3-5 September 2003. The three are from the 14th Research Institute and the Research Center of Electronic Engineering Technology, Nanjing

University of Science & Technology. For an excellent Western analysis of Chinese OTH-B radar development, see Sean O'Connor, "OTH Radar and ASBM Threat," *IMINT and Analysis*, November 11, 2008 at http://geimint.blogspot.com/2008/11/oth-radar-and-asbm-threat.html.

[98] See "Introduction to Yingpan Village" [营盘村简介], Xiangfan City Website, at http://www.xftxbsc.gov.cn/newview.asp?id=408&menutype=4; and "Second CPPCC Session of Xiangfan City Opens" [襄樊市政协十二届二次会议隆重开幕], *Hubei News*, February 3, 2009, at http://news.cnhubei.com/xwhbyw/xwwc/200902/t566879.shtml, accessed on February 9, 2010.

[99] For an overview of China's ASAT program, see Ian Easton, "The Great Game in Space: China's Evolving ASAT Weapons Programs and Their Implications for Future U.S. Strategy," The Project 2049 Institute *Occasional Paper,* June 24, 2009.

[100] Chen Dingchang [陈定昌] is said to have served as the chief designer of the ASAT/missile defense interceptor KKV, with Zhang Yiqun [张奕群] as the deputy chief designer for the KKV sub-system. Zhang is from the Second Academy's Second Design Department. A senior designer from the CASIC Fourth Academy's Fourth Design Department, Zheng Chenghuo [郑盛火], is said to be leading the development of the solid launch vehicle sub-system.

[101] For an excellent and reasonable analysis of the January 2010 missile defense interceptor test by a well regarded independent Chinese military-technical analyst, see KKTT, "A Preliminary Analysis of China's Ground-Based Mid-Course Missile Defense Interceptor Technology Test" [我国"陆基中段反导拦截技术试验"初步分析], KKTT blog, January 12, 2010, at http://liuqiankktt.blog.163.com/blog/static/121264211201001291954 98/, accessed on January 17, 2010. Also see Mark A. Stokes, *China's Strategic Modernization: Implications for U.S. National Security* (Carlisle, PA: Army War College, 1999), p. 115; and Ian Easton, "The Great Game in Space: China's Evolving ASAT Weapons Programs and Their Implications for Future U.S. Strategy," The Project 2049 Institute *Occasional Paper*, June 24, 2009.

[102] Yu Jixun (ed.), *Second Artillery Campaign Science* [*dierpaobing zhanyixue*] (Beijing: National Defense University Press, 2004), pp. 70, 75, and 142.

[103] Li Guoqiang, "New Strategy of the PLA Air Force" [中国空军新战略], *Wenhuibao*, (Hong Kong), November 26, 2009, at http://paper.wenweipo.com/2009/11/26/PL0911260003.htm, accessed on May 3, 2010.

[104] Hao Yunpeng, China's Telecommunications: Present and Future, Stanford: Center for International Security and Arms Control, June 1997. For China's long-range plans, see "Development and Policy Research on Information High Speed Highway," *Space Technology and Civil Products*, April 1996, pp. 21-26.

[105] "Development and Policy Research on Information High Speed Highway," *Space Technology and Civil Products*, April 1996, pp. 8-12.

[106] See, for example, Michael D. Swaine and Ashley J. Tellis, *Interpreting China's Grand Strategy: Present, Past, and Future* (Wash DC: Rand Corporation, 2000), pp. 129-130.

[107] Paul S. Giarra and Michael J. Green, "Asia's Military Balance at a Tipping Point," *Wall Street Journal*, July 17, 2009, at http://online.wsj.com/article/SB124776820445852755.html, accessed on April 20, 2010.

[108] For example, see Shi Yinhong, "Several Grand Strategy Issues Concerning Taiwan Require Facing Up To," *Strategy and Management*, 30 April 2000, pp. 27-32 (FBIS: CPP20000517000170).

[109] David A. Shlapak, David T. Orletsky, Toy I. Reid, Murray Scot Tanner, and Barry Wilson, *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Arlington, VA: RAND Corporation, 2009), p. 42.

[110] Among various sources, see Chung Chien, "High Tech War Preparation of the PLA: Taking Taiwan Without Bloodshed," *Taiwan Defense Affairs*, Vol. 1, October 2000, pp. 141-162. The guiding principle is contained in the eight character slogan of "victory with the first fight, rapid war rapid resolution" [初战决胜, 速战速决].

[111] Others do seem to believe that coercive measures such as a blockade or occupation of a few off-shore islands leaves too much to chance since the Taiwan leadership's threshold is difficult to calculate.

[112] Chong-Pin Lin, "The Military Balance in the Taiwan Strait," *The China Quarterly*, 1996.

[113] For an example of the shifting dynamics, see Richard Fisher, Jr., "The Air Balance on the Taiwan Strait," International Assessment and Strategy Center, at http://www.strategycenter.net/research/pubID.224/pub_detail.asp, accessed on May 18, 2010.

[114] Rich Chang, "Air Force Plans To Buy Jets That Need Shorter Runway," *Taipei Times*, January 23, 2006, p. 3, at http://www.taipeitimes.com/News/taiwan/archives/2006/01/23/2003290353, accessed on March 15, 2010.

[115] Airfields are said to be easy to attack and damage, but keeping them closed requires repeated and continual attacks, assuming the defender has a strong airfield recovery capability. Light, one time attacks probably will not eliminate an airfield, but may, for a limited period, keep its aircraft on the ground. Because their supply is limited and fragile, pilots or highly skilled maintenance technicians can be as valuable of a target as the aircraft themselves. Runways are another key target, although they generally will have only temporary effects. Striking runways may be necessary to shut down an airfield or fix an adversary in place for a short period of time.

[116] 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, accessed on May 6, 2010; Chong-Pin Lin, "The Military Balance in the Taiwan Strait," *The China Quarterly*, 1996, p. 579; and Brian Hsu, "Chen Visits Mountain Air Force Base," *Taipei Times*, December 15, 2000. Jiashan is reportedly is able to accommodate roughly 200 fighters and took roughly eight years and more than NT$27 billion to build, and was one of the military's largest engineering projects in recent decades. Its construction spanned from 1985 to 1993. The second underground aircraft shelter at Zhihang near Taidong began operations in 1993.

[117] According to one Taiwan source, China procured commercial satellite imagery in February 2002 from a South Korean company in order to provide precision three dimensional targeting data for its land attack and ballistic missiles. Precise targeting data had raised concerns in Taiwan that imagery could be used to program LACM flight paths around the north or south ends of the island. Analysis has shown that such technology could also be harnessed to allow the PLA's long-range LACMs (land, air and/or sea launched variants) to potentially defeat Taiwan's air defense systems by flying through the central mountain range from the east, exploiting radar blind spots, the background interference of the mountains, and Taiwan's air defense networks' natural tendency to expect and prime for threats emanating from a westerly direction. See Guo Nairi [郭乃日], *The Invisible War in the Taiwan Strait* [看不見的台海戰爭], (Xizhi City: Gaoshou Publishing, 2005), pp. 150-153.

[118] For discussions of the airbase survivability issue, see Tsai Ming-Yen, "Air Base Defense: China's Missile Attacks and Taiwan's Defensive Responses," *Taiwan Defense Review*, Vol.3, No.2, Winter 2002/2003, at http://www.taiwanus.net/Taiwan_Future/national_defence/2002/03_02/03_02_13_01.htm, accessed on April 2, 2010; *The Balance of Air Power in the Taiwan Strait*, (Arlington, VA: U.S.-Taiwan Business Council, 2010), p. 29; Li Hongming et.al.,"Methodology and Support for Engineering Corps Support for Airbase Runway Repair" [工兵支援機場跑道搶修作法之研究], Taiwan University project (E09514026)**,** undated**;** Gao Zhiyang, "Beyond Runway Repair – New Thinking on Passive Defense" [搶修跑道之外－機場被動防禦的新思維], *Defense International* (Taiwan), May 2006, at http://www.diic.com.tw/mag/mag261/261-38.htm, accessed on March 17, 2010; and "Airfield Damage Repair," Department of Defense Unified Facilities Criteria (UFC), August 12, 2002, at http://www.wbdg.org/ccb/DOD/UFC/ufc_3_270_07.pdf, accessed on March 17, 2010.

[119] Price T. Bingham, "Fighting From the Air Base," *Airpower Journal*, Summer 1987, at http://www.airpower.maxwell.af.mil/airchronicles/apj/apj87/sum87/bingham.html, accessed on April 23, 2010; John Stillion, "Fighting Under Missile Attack," *Air Force Magazine*, August 2009 (Vol. 92, No. 8), at http://www.airforce-magazine.com/MagazineArchive/Pages/2009/August%202009/0809fighting.aspx, accessed on March 20, 2010.

[120] *The Balance of Air Power in the Taiwan Strait*, (Arlington, VA: U.S.-Taiwan Business Council, 2010), p. 10.

[121] Shirley A. Kan, "Taiwan: Major U.S. Arms Sales Since 1990," *Congressional Research Service Report for Congress*, February 16, 2010, pp. 16-17, at http://www.fas.org/sgp/crs/weapons/RL30957.pdf, accessed on April 18, 2010.

[122] *The Balance of Air Power in the Taiwan Strait*, (Arlington, VA: U.S.-Taiwan Business Council, 2010), p. 25.

[123] See "Taiwan to Deploy LACM," *Taiwan Defense Review*, September 6, 2005; Mark A. Stokes, "The Chinese Joint Aerospace Campaign: Strategy, Doctrine, and Force Modernization" in James Mulvenon and David Finkelstein (ed.), *China's Revolution in Doctrinal Affairs* (Alexandria: CNA Corporation, 2005), pp. 291-302.

[124] "Taiwan To Produce At Least 80 Hsiungfeng-2E Cruise Missiles That Can Hit Mainland China" [传台湾将试射可攻大陆雄2E导弹年底产80套], *Global Times* (China), March 25, 2010, at http://news.qq.com/a/20100325/001200.htm, accessed on May 3, 2010.

[125] Ministry of Defense (MOD), Defense of Japan 2009, Chapter 1, section 3, p. 212, at http://www.mod.go.jp/e/publ/w_paper/pdf/2009/29Part3_Chapter1_Sec3.pdf, accessed on December 21, 2009. Like most defense establishments, Japan views airbase attacks as a potential challenge. As the defense white paper explains, "in the event of an armed attack on Japan, such attacks are…likely to begin with surprise air attacks using aircraft or missiles."

[126] See Ministry of Defense (MOD), "The Roles: Defense Ability of the JASDF," (Ministry of Defense, Tokyo, 2009), *Japan's Air Self Defense Force Official Website*, at http://www.mod.go.jp/asdf/english/mission/mission02.html, accessed January 4, 2009; and 2008 Source Book, "World Military Aircraft Inventory: Japan," *Aviation Week & Space Technology*, January 28, 2008, p. 271, at http://www.aviationweek.com/aw/sourcebook/content.jsp?channelName=pro&story=xml/sourcebook_xml/2008/01/28/AW_01_28_2008_p0271-27282-81.xml&headline=World%20Military%20Aircraft%20Inventory%20-%20Japan, accessed on January 4, 2009. An initial order of 130 Mitsubishi F-2s has been cut to 94 with at least 32 dedicated to training. See "F-2 Attack Fighter, Japan," airforce-technology.com, at http://www.airforce-technology.com/projects/f2/, accessed on January 4, 2009.

[127] The new procurement process will emphasize factors such as air-to-air capability (necessary in the face of advanced fighter aircraft and missile systems deployed by China and Russia), industrial participation (a traditional feature of Japanese aircraft acquisition efforts), and low programmatic risk and price. "Japan Mulls F-35 Purchase As Next Main Fighter Jet: Report," *Defense News*, November 23, 2009, at http://www.defensenews.com/story.php?i=4389389, accessed on January 2, 2009.

[128] Ministry of Defense (MOD), "Organization (JASDF) Japan Air Self-Defense Force," at http://www.mod.go.jp/asdf/english/formation/organization01.html, accessed on December 28, 2009. The Western Air Defense Force is comprised of the 5th and 8th Air Wings at Nyutabaru and Tsuiki, respectively; and the 2nd Air Defense Missile Group, the Western Air Defense Force Headquarters Support Flight Squadron and Western Aircraft Control and Warning Wing at Kasuga. The Southern Composite Air Division is comprised of the 83rd Air Wing, the 5th Air Defense Missile Group, and the Southwestern Aircraft Control and Warning Wing at Naha, Okinawa.

[129] This move strengthens early warning and bilateral command and control, and the move is viewed as conducive for joint cooperation between US and Japanese forces as the new bilateral air operations center will link up with the 613th Air and Space Operations Center (AOC) at Hickham AFB in Hawaii which synchronizes all US air, space and cyberspace missions in the theater. Bilateral Joint Operations Coordination Command Center (BJOCC) under the USFJ headquarters building is said to hold up to 150 people in wartime and every position on the main floor has a Japanese counterpart working alongside US personnel to foster bilateral cooperation and augment bilateral operability. See Rita Boland, "Partnership in the Pacific," *Signal*, June 2008, at http://findarticles.com/p/articles/mi_qa5438/is_200806/ai_n27901531/?tag=content;col1, accessed on December 14, 2009; and General Howie Chandler (USAF), "An Airman's Perspective: Air, Space, and Cyberspace Strategy for the Pacific," *Strategic Studies Quarterly*, Summer 2008, p. 15, at http://www.au.af.mil/au/ssq/2008/Summer/chandler.pdf, accessed on January 4, 2010; and Vince Little, "Control Hub Used To Direct Exercise," *Stars and Stripes*, November 17, 2007, at http://www.stripes.com/article.asp?section=104&article=50313, accessed on December 14, 2009; and Leandra D. Hernandez, "Ceremony Marks Japan's Air Defense Command Move to Yokota," *Yokota Air Base News*, February 20, 2008, at http://www.yokota.af.mil/news/story.asp?id=123088254, accessed on January 4, 2010.

[130] Ministry of Defense (MOD), Defense of Japan 2009, (Ministry of Defense, Tokyo, 2009), reference section, at http://www.mod.go.jp/e/publ/w_paper/pdf/2009/45Location.pdf, accessed on December 21, 2009.

[131] Ministry of Defense (MOD), Japan's BMD, (Ministry of Defense, Tokyo, February 2009), p. 15, at http://www.mod.go.jp/e/d_policy/bmd/bmd2009.pdf, accessed on December 28, 2009. Japan's first FPS-5 radar, deployed on Shimo-koshiki island in the Sasebo District, was officially unveiled on May 20, 2009. The FPS-5 radar costs an estimated 18 billion Yen per unit, and by fiscal year (FY) 2011 will also be deployed at Ominato, Sado and Yozadake, with an additional FPS-5 radar being deployed at Mineokayama, outside Tokyo, as a research facility. Seven FPS-3 radar sites at (from North to South) Tobetsu, Kano, Otakine, Wajima, Kasadoriyama, Kyogamisaki and Seburi

will be upgraded and are expected to be operational by FY2009. These radar sites and their associated air defense units are organized into six air defense missile groups, which are grouped geographically with their associated air wings and central aircraft control and warning wings into four air defense forces, each of which will maintain one advanced FPS-5 missile defense radar site. Also see "Japan's Most Advanced Missile Defense Radar Publicly Unveiled [日最尖端導彈監測雷達公開亮相], *TaKungBao*, May 21, 2009, at http://www.takungpao.com/news/09/05/21/junshi03-1085706.htm, accessed on December 21, 2009.

[132] See "Successful PAC-3 Flight Test," Ministry of Defense website, at http://www.mod.go.jp/e/jdf/no11/special.html. Patriot-3s (PAC-3s) are assigned to four fire units at Narashino, Takeyama, Kasumigaura and Iruma, respectively, under the 1st Air Defense Missile Group. One PAC-3 fire unit (FU) was also deployed at Gifu under the 4th Air Defense Missile Group, and another PAC-3 FU was deployed at the Air Defense Missile Training Group and 2nd Technical School in Hamamatsu. See Ministry of Defense (MOD), *Defense of Japan 2009*, (Ministry of Defense, Tokyo, 2009), Chapter 1, Section 2, p. 185, http://www.mod.go.jp/e/publ/w_paper/pdf/2009/28Part3_Chapter1_Sec2.pdf, accessed on December 21, 2009.

[133] Ministry of Defense (MOD), Defense of Japan 2009, (Ministry of Defense, Tokyo, 2009), Chapter 1, Section 2, p. 185, http://www.mod.go.jp/e/publ/w_paper/pdf/2009/28Part3_Chapter1_Sec2.pdf, accessed on December 21, 2009.

[134] Russell Hsiao, "China's Fifth Generation Fighters and the Changing Strategic Balance," *China Brief*, Vol. 9, Iss. 23, November 19, 2009, http://www.jamestown.org/programs/chinabrief/single/?tx_ttnews[tt_news]=35745&tx_ttnews[backPid]=25&cHash=125ffd4175, accessed on November 30, 2009.

[135] United States Air Force, "Factsheets: 35th Fighter Wing Mission," *Misawa Air Base*, http://www.misawa.af.mil/library/factsheets/factsheet.asp?id=14099, accessed on January 11, 2010.

[136] United States Air Force, "Factsheets: 18th Wing," *Kadena Air Base*, http://www.kadena.af.mil/library/factsheets/factsheet.asp?id=12263, accessed on January 11, 2010.

[137] United Stated Navy, "Commander 7th Fleet Forces," U.S. 7th Fleet, http://www.c7f.navy.mil/forces.htm, accessed on January 11, 2010.

[138] Wendell Minnick, "RAND Study Suggests U.S. Loses War with China," *Defense News*, October 16, 2008, http://www.defensenews.com/story.php?i=3774348, accessed January 11, 2010.

[139] David A. Shlapak, David T. Orletsky, Toy I. Reid, Murray Scot Tanner, and Barry Wilson, *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Arlington, VA: RAND Corporation, 2009), p. 42. At least 100 airfields in Japan may be capable of handling fighter operations, although the military only operates 32. In the detailed analysis by RAND, runways shorter than 9000 feet would require a single ballistic missile to temporarily halt flight operations, and two for runways longer than 9000 feet.

[140] Nao Shimoyachi, "Japan Mulled Buying Cruise Missiles for Pre-Emptive Self-Defense: Ishiba," *Japan Times*, January 25, 2005, at http://search.japantimes.co.jp/cgi-bin/nn20050125f2.html, accessed on May 5, 2010.

[141] For an excellent overview of China-India military dynamics, see Srikanth Kondapalli, "The Chinese Military Eyes South Asia," in Andrew Scobell and Larry M. Wortzel (eds), *Shaping China's Security Environment: the Role of the People's Liberation Army* (Carlisle: U.S. Army War College, 2006, pp. 197-282, at http://www.strategicstudiesinstitute.army.mil/pdffiles/PUB709.pdf, accessed on May 1, 2010.

[142] "India Set to Launch Agni 5 Missile Within Year," Nuclear Threat Initiative India Profile, Feb. 12, 2010, at http://www.globalsecuritynewswire.org/gsn/nw_20100212_3870.php, accessed on May 3, 2010.

[143] "Agni-III successfully test fired, ready for induction (Third Lead), *Thaindian News*, February 7, 2010, at http://www.thaindian.com/newsportal/uncategorized/agni-iii-successfully-test-fired-ready-for-induction-third-lead_100316321.html, accessed on May 17, 2010.

[144] Krittivas Mukherjee, "India to test 5000-km Agni-V missile within year," *Reuters*, February 10, 2010, at http://in.reuters.com/article/topNews/idINIndia-46059620100210?pageNumber=2&virtualBrandChannel=0, accessed on May 17, 2010.

[145] "Indigenous Technology to Increase Range of Indian Missiles by a Third," *Aviation and Aerospace*, May 14, 2008, at http://www.domainb.com/aero/space/launch_veh/20080514_technology.html, accessed on May 3, 2010. The engineer explained ''as the chromium coating evaporates with the enormous frictional heat generated during hypersonic flight, it reacts with the oxygen atoms present in the atmosphere and produces chromium oxide. This reaction is exothermic, that is producing more heat, thereby decreasing the density of the air around the nose of the missile. As the pressure reduces, so does the drag force, which in turn enables the missile to increase its range.''

[146] Zhang Xu, "India Develops Sub-sonic Stealth Cruise Missile," *Xinhua*, April 11, 2010, at http://english.cri.cn/6966/2010/04/11/2021s562399.htm, accessed on May 2, 2010. A rough Pakistani equivalent is the Babur (also called Hatf VII), with an estimated range of between 500 and 700 kilometers.

[147] "India to Re-test Ballistic Missile Defence Shield," *Thaindia News*, April 11, 2010, at http://www.thaindian.com/newsportal/sci-tech/india-to-re-test-ballistic-missile-defence-shield_100346454.html, accessed on May 17, 2010. Its Advanced Air Defence (AAD) system is envisioned for terminal defenses and Prithvi Air Defence (PAD) for mid-course.

[148] The most recent successful test, conducted on March 6, 2009, resulted in the successful interception of a decoy enemy missile at an altitude of 75km by a two-stage interceptor launched from a mobile platform from the Integrated Test Range (ITR) at Wheeler Island in Orissa. The two previous successful tests occurred on November 27, 2006 and December 6, 2007. See Sitanshu Kar, "Third Successful Test Of Ballistic Missile Interceptor," *Government of India Press Information Bureau*, March 6, 2009, http://pib.nic.in/release/release.asp?relid=48249, accessed on May 17, 2010.

[149] Ninan Koshy, "US plays matchmaker to India, Israel," *Asia Times*, June 10, 2003, at http://www.atimes.com/atimes/South_Asia/EF10Df03.html, accessed on May 4, 2010.

[150] "Firing off missile claims," *Global Times*, February 12, 2010, at http://military.globaltimes.cn/china/2010-02/505529.html, access on May 12, 2010; and "India's Missile Tech A Decade Behind That of China," *Times of India*, February 14, 2010, at http://timesofindia.indiatimes.com/india/Indias-missile-tech-a-decade-behind-that-of-China/articleshow/5572984.cms, accessed on May 9, 2010.

[151] See Taylor Dinerman, "India's Missile Defense: Changing the Nature of the Indo-Pakistani Conflict," *Space Review*, January 26, 2009, at http://www.thespacereview.com/article/1292/1, accessed on May 2, 2010; *Ballistic and Cruise Missile Threat* (NASIC-1031-0985-09), (Dayton: National Air and Space Intelligence Center, 2009); and"India Plans Radars in Space To Boost Missile Defense System," *Thaindian News*, March 9, 2009, http://www.thaindian.com/newsportal/uncategorized/india-plans-radars-in-space-to-boost-missile-defence-system_100164598.html, accessed May 17, 2010; and Madhusree Mukerjee, "Perilous Pursuit," *Scientific American*, March 2008, at http://www.scientificamerican.com/article.cfm?id=perilous-pursuit, accessed on May 5, 2010.

[152] Andrew Erickson and David Yang, "On the Verge of a Game-Changer: A Chinese Antiship Ballistic Missile Could Alter the Rules in the Pacific and Place U.S. Navy Carrier Strike Groups in Jeopardy," *U.S. Naval Institute Proceedings,* Vol. 135, No. 3, (May 2009), pp. 26-32; Paul S. Giarra, "A Chinese Anti-Ship Ballistic Missile: Implications for the USN," testimony before the U.S.-China Economic and Security Commission, June 11, 2009, at http://www.uscc.gov/hearings/2009hearings/written_testimonies/09_06_11_wrts/09_06_11_giarra_statement.pdf, accessed on April 20, 2010; Andrew F. Krepinevich, *Why AirSea Battle?*, (Washington DC: Center for Strategic and Budgetary Assessments, 2010), at http://www.csbaonline.org/4Publications/PubLibrary/R.20100219.Why_AirSea_Battle/R.20100219.Why_AirSea_Battle.pdf, accessed on February 23, 2010; and Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, and Kevin L. Pollpeter, *Entering The Dragon's Lair: Chinese Anti-Access Strategies And Their Implications For The United States* (Arlington, VA: RAND Corporation, 2007), at http://www.rand.org/pubs/monographs/2007/RAND_MG524.pdf, accessed on March 20, 2010.

[153] *Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), p. 31, at http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf, accessed on May 23, 2010.

[154] *Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), p. 31-33, at http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf, accessed on May 23, 2010.

[155] *Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), p. 33, at http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf, accessed on May 23, 2010.

[156] For example, see Andrew F. Krepinevich, *Why AirSea Battle?*, (Washington DC: Center for Strategic and Budgetary Assessments, 2010), at http://www.csbaonline.org/4Publications/PubLibrary/R.20100219.Why_AirSea_Battle/R.20100219.Why_AirSea_Battle.pdf, accessed on February 23, 2010; and Robert D. Kaplan, "The Geography of Chinese Power: How Far Can Beijing Reach on Land and at Sea?," *Foreign Affairs*, May/June 2010. Anti-access strategies aim to prevent US forces from operating from fixed land bases in a theater of operations. Area-denial operations aim to prevent the freedom of action of maritime forces operating in the theater.

[157] See Jan van Tol, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas, *AirSea Battle: A Point-of-Departure Operational Concept* (Washington DC: Center for Strategic and Budgetary Assessments, 2010), xiii.

[158] For an excellent overview, see Bruce M. Sugden, "Speed Kills: Analyzing the Deployment of Conventional Ballistic Missiles," *International Security*, Vol. 34, No. 1 (Summer 2009), pp. 113-146.

[159] For perspectives on the implications of China's rising power, see Paul Giarra and Michael Green, "Asia's Military Balance at a Tipping Point," *Asia Wall Street Journal*, July 17, 2009; David A. Shlapak, David T. Orletsky, Toy I. Reid, Murray Scot Tanner, and Barry Wilson, *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute*, (Arlington: RAND Corporation, 2009), at http://www.rand.org/pubs/monographs/2009/RAND_MG888.pdf, accessed on January 10, 2010.

[160] For an interesting assessment of this argument, see Joshua Cooper Ramo, *The Beijing Consensus* (London: Foreign Policy Centre, 2004), pp. 44-46, at http://fpc.org.uk/fsblob/244.pdf, accessed on April 3, 2010.

[161] "Reciprocal unilateralism" is an adaption of a concept outlined in Robert A. Kapp, "Once in a While, More is Less," *China Business Review*, January 1, 1998, at http://www.chinabusinessreview.com/public/9801/letter.html, accessed on February 14, 2010.

[162] For a summary of innovative solutions that have been advocated, see Gao Zhiyang, "Beyond Airfield Recovery: New Thinking on Passive Defense" [搶修跑道之外－機場被動防 禦的新思維], *Global Defense* (Taiwan), May 2005 (Issue 261), http://www.diic.com.tw/mag/mag261/261-38.htm, accessed on May 2, 2010.

[163] For a brief introduction to the concept of reciprocal unilateralism, see Robert A. Kapp, "Once in a While, Less is More," *China Business Review*, January 1998, at https://www.chinabusinessreview.com/public/9801/letter.html, accessed on February 20, 2010.

[164] China's Precision Machinery Import and Export Corporation (CPMIEC) reportedly signed a sales agreement with Pakistani counterparts in 1988. With sufficient evidence accumulated by 1991, the Bush administration imposed legally mandated sanctions on CPMIEC and other entities, then sought Chinese assurances to abide by the guidelines and parameters of the Missile Technology Control Regime (MTCR) in exchange for lifting of the sanctions. With Chinese MTCR assurances provided in February 1992, the sanctions were lifted a month later. In the wake of the September 1992 announcement on the sale of 150 F-16 A/B fighters, reports surfaced that CPMIEC made missile-related sales to Pakistani customers in violation of its MTCR commitment. By August 1993, MTCR-related sanctions were re-imposed, including a ban on U.S. sales of satellites and related equipment. The sanctions were lifted the following year after further Chinese assurances to abide by the MTCR. See, for example, *Joint United States-People's Republic of China Statement on Missile Proliferation*, October 4, 1994, at http://www.nti.org/db/China/engdocs/mtcrusch.htm, accessed on March 1, 2010; and Norman Kempster and Rone Tempest, "U.S. Imposes Sanctions on China, Pakistan Over Missile Deal," *Los Angeles Times*, August 26, 1993.

[165] Evan S. Medeiros, *Reluctant Restraint: The Evolution of China's Nonproliferation Policies and Practices, 1980–2004* (Stanford, CA: Stanford University Press, 2007), pp. 135-136.

[166] See "The New York Times Interview with President Chen Shui-bian," Presidential Office, October 18, 2007, at http://www.president.gov.tw/en/prog/news_release/document_content.php?id=1105499570&pre_id=1105499570&g_category_number=145&category_number_2=145, accessed on May 3, 2010; "Chinese Missiles Key to Taiwan Talks," *UPI*, June 6, 2008, at http://www.upi.com/Top_News/2008/06/06/Chinese-missiles-key-to-Taiwan-talks/UPI-64491212796048/, accessed on May 1, 2010. "Inside Information on Hu Jintao's Intent to Withdraw Missiles Opposite

Taiwan" [胡锦涛拟撤对台导弹内情], *Yazhou zhoukan*, January 11, 2009, at http://www.yzzk.com/cfm/Content_Archive.cfm?Channel=ag&Path=4471927941/02ag6a.cfm, accessed on March 23, 2009; "President Ma Urges China to Scrap Missiles," October 20, 2009, at http://www.chinapost.com.tw/taiwan/china-taiwan-relations/2009/10/20/229285/President-Ma.htm, accessed on May 2, 2010.; "No Peace Unless China Removes Missiles: Ma," *China Post*, April 7, 2010, at http://www.chinapost.com.tw/taiwan/china-taiwan-relations/2010/04/07/251444/No-peace.htm, accessed on May 2, 2010. For more more recent reporting, see Annie Huang, "Taiwan Leader Says China May Dismantle Missiles," *Associated Press/Global Security Newswire*, May 19, 2010, at http://www.globalsecuritynewswire.org/gsn/nw_20100519_6866.php, accessed on May 21, 2010.

[167] See one report, see Jiang Xun, "Inside Information on President Hu Jintao's Plan to Withdraw Missiles" [胡锦涛拟撤对台导弹内情], *Asia Weekly* [亚洲周刊], January 2, 2009, at http://www.yzzk.com/cfm/Content_Archive.cfm?Channel=ag&Path=4471927941/02ag6a.cfm, accessed on April 29, 2010.

[168] Thomas Graham and Dinshaw Mistry, Two Treaties to Contain Missile Proliferation, *Disarmament Diplomacy*, Iss. No. 82, Spring 2006, at http://www.acronym.org.uk/dd/dd82/82tgdm.htm, accessed on April 16, 2010; J. Jerome Holton, Lora Lumpe, and Jeremy J. Stone, "Proposal For a Zero Ballistic Missile Regime," 1993 Science and International Security Anthology AAAS: Washington, 1993, pp. 379-396; "Banning Ballistic Missiles: In the Long Run, It may be Easier than Shooting Them Down," *Western States Legal Foundation Issue Brief*, Summer 2001, at http://www.wslfweb.org/docs/bmcrbrief.pdf, accessed on April 5, 2010; and Richard H. Speier, "A Nuclear Nonproliferation Treaty for Missiles?," in Henry Sokolski (ed), *Fighting Proliferation: New Concerns for the Nineties*, (Maxwell Air Force Base: Alabama Air University Press), January 1996; and Ron Huisken, "Globalising the INF Treaty: The Best Way To Inhibit The Proliferation Of Long-Range Missiles?," *Working Paper No. 409*, Australian National University Strategic and Defence Studies Centre, May 2008.

[169] Joint U.S.-Russian Statement on the Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles at the 62nd Session of the UN General Assembly (October 25, 2007), at http://moscow.usembassy.gov/st_10252007.html, accessed on April 4, 2010.; and Conor Sweeney, "U.S. And Russia Urge Other States To Join Missile Pact," *Reuters*, October 28, 2007. Also see Statement by H.E. Mr. Sergey Lavrov, Minister of Foreign Affairs of the Russian Federation, at the Plenary meeting of the Conference on Disarmament, Geneva, 12 February 2008. Also see Alexei Arbatov, *Missile Defence and the Intermediate Nuclear Forces Treaty*, study prepared for the International Commission on Nuclear Nonproliferation and Disarmament, March 2009, at www.icnnd.org/research/Arbatov_INF_Paper.rtf, accessed on May 2, 2010.