



## The Looming Taiwan Fighter Gap

US-Taiwan Business Council  
October 1, 2012



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## **FOREWORD**

The US-Taiwan Business Council is committed to providing our members and the broader policy-making community with political, economic, and strategic insight into American interests in our relationship with Taiwan. It is part of our continuing efforts to offer value-added benefits to all our member companies, as well as to all those who are active in the bilateral relationship.

In the period after the September 2011 notification to Congress of an upgrade program for Taiwan's existing fleet of 145 F-16A/B fighters, the messaging from both Washington and Taipei would have us believe that this had been the intent for Taiwan's air force modernization all along – for Taiwan to choose between upgrading its F-16A/Bs or to purchase new F-16C/Ds. Following this line of thinking, the upgrade program announcement in 2011 addressed all of Taiwan's air power needs for the foreseeable future.

This is simply not the case.

Over the past decade and more, China's People's Liberation Army (PLA) Air Force has made significant qualitative and quantitative improvements to its fighter fleet, a challenge that is driving Taiwan's requirement for a robust and modern fighter force. Despite the clear need for more and modern aircraft, that Taiwan requirement was immediately plunged into the political realm in 2006 when the administration of former President George W. Bush refused to accept Taiwan's Letter of Request (LOR) for 66 new F-16 C/Ds.

Since 2006, Taiwan's air defense requirement has served as a political football for the Bush, Hu Jintao, Barack Obama, and Ma Ying-jeou governments – with all four jockeying in an attempt to come out on top. As it stands right now, it is clear that the Chinese position has prevailed. Using its political and economic clout, China seems to have been able to persuade policy-makers in Washington that they have already done enough, and that no further action on the Taiwan fighter requirement is needed.

Taiwan approaches the retirement of its F-5 fleet, and is facing declining availability for its Mirage 2000s and F-CK-1A/B Indigenous Defense Fighters (IDFs). By 2016, as Taiwan begins to withdraw portions of its existing F-16A/B fighter fleet for modernization under the upgrade program, Taiwan faces a precipitous fighter gap.

With up to a squadron of F-16A/B fighters unavailable for each year of the upgrade, and at an estimated 70% availability, Taiwan may be left with as few as 73 operational F-16A/B fighters to handle its peace time and war time contingencies. This number is so low as to create a destabilizing force in the Taiwan Strait, and could encourage the PLA to undertake a military solution.

This US-Taiwan Business Council report examines the threat from China and the extent to which Taiwan faces a looming fighter gap. We then make some recommendations on how the United States and Taiwan should proceed.

This report was produced by the Council's membership, as well as with the help of several outside experts who spent their valuable time reviewing, fact-checking, and otherwise contributing to this report. Their perspectives and sage advice throughout the process proved invaluable. I wish to express my sincere gratitude



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to my colleague Lotta Danielsson whose dedication to the production of this report made the final product possible.

The Council believes we can continue to contribute in a meaningful way to the health of America's relationship with Taiwan. However, we can only continue that work with the tremendous support of our member companies, for which we are deeply grateful.

A handwritten signature in black ink that reads "Rupert J. Hammond-Chambers". The signature is written in a cursive style with a large, prominent initial "R".

Rupert J. Hammond-Chambers  
President  
US-Taiwan Business Council

## **INTRODUCTION**

Lessons and experiences from previous Taiwan Strait crises have shown that it is imperative for Taiwan to maintain a measure of qualitative superiority over China – not only to attempt to prevail in conflict, but also to reinforce deterrence, to allow Taiwan to negotiate from a position of strength, and to prevent war. However, a careful and objective analysis of the current balance of air power in the Taiwan Strait reveals that Taiwan's current air defense forces are only marginally capable of meeting the island's air defense needs, and that it faces real and significant future challenges in maintaining its current capabilities.

The U.S. decision in 2011 to assist Taiwan with the mid-life upgrade (MLU) of its existing fleet of F-16A/B fighters will significantly improve Taiwan's air defense capabilities. Nevertheless, the upgrade program still does not adequately address all of Taiwan's legitimate air defense requirements. Without additional procurement programs, a tangible and substantial front-line fighter gap will develop in Taiwan within the next five to ten years, as a significant portion of the Taiwan Air Force (TAF) aircraft inventory reaches the end of its useful service life.

Taiwan's fleet of Mirage 2000s and the F-CK-1A/B Indigenous Defense Fighter (IDF) both contend with serious availability issues, and may be facing retirement after 2018. The shortfall in front-line fighters will be further exacerbated by the rapidly approaching obsolescence of Taiwan's fleet of F-5 Lead-In Fighter Training (LIFT) aircraft. Together, this will reduce the Taiwan air defense force structure to rely primarily on a small fleet of 145 F-16A/Bs whose operational rate takes the number of available planes to approximately 107. During the scheduled upgrade program for these fighters, however, as many as a squadron (24) at a time of F-16A/Bs will be unavailable for service, further reducing Taiwan's air defense forces.

By 2023, at the expected end of the upgrade program, Taiwan's operationally-available fighter strength will have declined to a point where the TAF will no longer possess the minimum requisite number of combat aircraft necessary to defend its air space from Chinese aggression or military coercion. Moreover, the quantitative shortfall is certain to also erode the quality of Taiwan's air force, manifesting in decreased aircraft performance, reduced pilot training opportunities, and lack of pilot experience.

This significant air power shortfall will emerge in Taiwan while China continues to aggressively modernize and expand its missile strike capabilities, and while the People's Liberation Army (PLA) is simultaneously and rapidly introducing modern combat aircraft into service in large numbers.

The United States has both a clear legal and moral obligation to respond to the ongoing Chinese intimidation tactics and attempts at coercion of Taiwan. Under the Taiwan Relations Act (TRA), Washington must ready itself and Taiwan to resist that coercion. The germane parts of the TRA make it the policy of the United States:

- *to consider any effort to determine the future of Taiwan by other than peaceful means, including by boycotts or embargoes, a threat to the peace and security of the Western Pacific area and of grave concern to the United States;*
- *to provide Taiwan with arms of a defensive character; and*

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- *to maintain the capacity of the United States to resist any resort to force or other forms of coercion that would jeopardize the security, or the social or economic system, of the people on Taiwan.*<sup>1</sup>

Arguably the mere existence of China's current large arsenal of ballistic missiles, land attack cruise missiles (LACMs), and fighter aircraft opposite Taiwan is "*a threat to the peace and security of the Western Pacific,*" as it is undermining the long-standing, stability-enhancing military balance in the region. Clearly targeted at Taiwan, China's standing arsenal is certainly a means of coercion even if the missiles and aircraft are never used.

The United States and Taiwan need to craft and implement counter-coercive strategies that undercut the utility of Chinese aerospace power, while demonstrating Taiwan's ability to defend its airspace in peacetime and wartime.

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<sup>1</sup> Public Law 96-8, "*Taiwan Relations Act*" Washington, D.C., 96th Congress, January 1, 1979.

## **THREAT ASSESSMENT**

China sees *de jure* independence for Taiwan as a prime national security threat, and Chinese military policies have long been characterized as primarily intended to prepare for contingencies involving Taiwan.

Since the end of the Cold War, the PLA has been internalizing and applying lessons of contemporary warfare, in particular from what it believes is an ongoing revolution in military affairs. In considering the threat of Taiwan independence, the PLA is especially taken with the notion that coercive aerospace power can be utilized up and down the escalation ladder of conflict – from the low rungs of peacetime intimidation and coercion, all the way up the ladder to a punishing aerospace campaign against key Taiwan military and civilian assets.

When combined with political, psychological, and other operations – certainly including electronic/information/cyber warfare, although such capabilities are outside the scope of this report – the object of this PLA strategy in peacetime is twofold. First, the People’s Republic of China (PRC) seeks to constrain Taiwan’s interactions with the outside world, while compelling its leaders to abide by Chinese strictures and influencing them to conclude that arms procurement is a futile activity in the face of an overwhelmingly lethal PLA. Second, the PRC seeks to likewise convince outside partners that offering security assistance to Taiwan is futile.

The object of a wartime coercive aerospace campaign would be to deny the island’s leadership the ability to conduct military operations of any impact, while simultaneously paralyzing the Taiwan government and broadly hindering its ability to function.

### ***Learning from Our Lessons***

The PLA has carefully studied recent coercive air campaigns, including U.S and NATO operations against Serbia during the Kosovo war of 1999 and U.S operations during the two Gulf Wars. Similarly, the PLA is likely studying Israel’s 2006 air campaign against Hezbollah in Lebanon. However, it is as yet uncertain precisely what lessons the PLA is learning from these operations. On the one hand, PLA writings suggest a relatively high confidence in the use of coercive aerospace power to meet Chinese objectives in a conflict. On the other, it is unknown which conclusions the PLA is drawing about the two Gulf Wars and the Lebanon war, in which aerospace power proved inconclusive. The PLA will need to reckon with those instances as it fine-tunes its aerospace power doctrine. In the meantime, the PLA’s strong preference remains for what it calls “no contact” warfare – the avoidance of protracted ground force engagement.

The PLA has carefully studied Operation Desert Storm, Operation Allied Force, and Operation Iraqi Freedom in part to develop strategies to defend against America’s overwhelming capabilities in precision-guided warfare. But just as importantly, it also seeks to apply the lessons learned from America’s successes and failures to its own coercion of Taiwan.

Those lessons are fourfold:

1. The effective application of aerospace power requires tight linkages between C4ISR<sup>2</sup> systems, the PLA Air Force (PLA-AF), the PLA Second Artillery Corps (which operates China's missile force), and PLA units responsible for Electronic Warfare (EW), Information Warfare (IW), and strategic Intelligence, Surveillance, and Reconnaissance (ISR)
2. Large numbers of precision-guided munitions (PGMs) are needed to destroy strategic, logistical, and purely military targets
3. A mass attack on an enemy's command and control (C2) systems can lead to a rapid collapse of the enemy's defenses.
4. Psychological operations can reinforce the aerospace campaign's message; that the coercer's objective is limited, and that resistance is futile. The PLA seems to have concluded that for such a campaign to work, surprise and "shock and awe" are critical.<sup>3</sup>

The PLA believes that there are geopolitical lessons, in addition to military doctrinal ones, to be learned from these operations as well. The PRC, for example, attributes Serbia's failure to resist the coercive air campaign in 1999 not only to military factors (e.g. misuse of decoying) but also to a collapse in Russia's support for Belgrade. Therefore the PRC is preparing the ground – prior to any initiation of conflict – for the similar isolation of Taiwan from the support of the international community. U.S. arms sales to Taiwan are consequently a key target for China's psychological warfare in its attempts to isolate the island.<sup>4</sup>

Indeed, a Kosovo-type campaign is particularly attractive to PLA planners – this is the war the PLA wants to fight. PLA analysts have begun to integrate these lessons of coercive airpower and views regarding an aerospace campaign as part of what they call "firepower warfare" (*huolizhan*).<sup>5</sup> In employing firepower warfare, the PLA would use short-range ballistic missiles (SRBMs), LACMs, and PGM-armed strike aircraft to rapidly degrade and destroy enough of Taiwan's capability that it makes resistance appear futile. Meanwhile information operations would undermine the will of both the military and the population it is protecting to fight back. The end result obviates the need for the PLA to commit ground troops into combat operations.

To prepare to wage such a campaign, a guiding PLA objective since as early as 2004 has been "informatization." It is a term meant to capture both the importance of information technology in modern weapons systems, and how maintaining dominance over the flow of information has become a central focus for modern militaries. To enhance the lethality and effectiveness of its ballistic missiles, cruise missiles, and multi-role fighters, the PLA has therefore invested heavily in C4ISR systems and electronic warfare capabilities.

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<sup>2</sup> Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance

<sup>3</sup> For a very useful survey of lessons the PLA is drawing from contemporary warfare, see Dean Cheng and June Dreyer's chapters in Scobell, Andrew, David Lai, and Roy Kamphausen, "Chinese Lessons From Other Peoples' Wars" Strategic Studies Institute, November 2011, at [www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubid=1090](http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubid=1090).

<sup>4</sup> See "Chinese Reactions to Taiwan Arms Sales" US-Taiwan Business Council and The Project 2049 Institute, March 2012, at [www.us-taiwan.org/reports/2012\\_chinese\\_reactions\\_to\\_taiwan\\_arms\\_sales.pdf](http://www.us-taiwan.org/reports/2012_chinese_reactions_to_taiwan_arms_sales.pdf).

<sup>5</sup> Schriver, Randall and Mark Stokes, "Evolving Capabilities of the Chinese People's Liberation Army: Consequences of Coercive Aerospace Power for United States Conventional Deterrence" The Project 2049 Institute, August 20, 2008, p. 10, at [project2049.net/documents/ChineseCoerciveAerospaceCampaign.pdf](http://project2049.net/documents/ChineseCoerciveAerospaceCampaign.pdf).

### ***The Missile Threat***

The PRC has long viewed missiles as a prime means of intimidation, because it is difficult and expensive to defend against them, and their mobility makes them difficult to suppress.

In what has become known as the Third Taiwan Strait Crisis, the PLA actually launched missiles into the waters off Taiwan in 1995 and 1996. This was presumably to intimidate Taiwan's leadership while also influencing the Taiwan populace during an election season. Many outside observers concluded that these missile tests were a strategic failure – they generally served to bring the U.S. and Taiwan closer together, with the U.S. responding by sending additional ships to the region, including two carrier battle groups. The fact remains, however, that Beijing did not see these missile tests as failures in that way. Indeed, in China's view the seriousness of the U.S. response was suggestive of how effective missiles could be if used properly.

The PLA has since vastly expanded its missile arsenal, building a missile-centric military and creating a uniquely high-threat environment in the Taiwan Strait. Examining the fielded Chinese missile capabilities, even just in terms of numbers, proves daunting not only for Taiwan but for other militaries in the region. Given the focus by the PLA on Taiwan, however, it is clear that no other nation in the world faces a similar extant missile threat.

According to estimates by the U.S. Department of Defense (DoD), by late 2011 the PLA had deployed 1,000-1,200 SRBMs on approximately 200-250 mobile transporter-erector-launchers (TELs), as well as 200-500 Ground-Launched Cruise Missiles (GLCMs) on 40-55 mobile launchers to units stationed opposite Taiwan. Since then, "*China has fielded new SRBM systems, added additional missile brigades in southeastern China, and upgraded the lethality of its existing SRBM force by introducing variants with improved ranges, accuracies, and payloads.*"<sup>6</sup> It is estimated that newer models of SRBMs have ranges of 300-500km, with increased precision and many warhead options, including sub munitions.<sup>7</sup> Intelligence estimates in 2012 by Taiwan's Ministry of National Defense (MND) puts the total number of PLA land attack missiles – tactical ballistic missiles (TBMs) and LACMs – at over 1,600, having increased by more than 200 from the previous year. MND also indicated that an increasing number of missiles are equipped with precision guidance systems.<sup>8</sup>

An earlier Taiwan MND study concluded that even with a force of only 800 SRBMs, China would be able to sustain five waves of missile strikes (with 150 launchers active per wave) against Taiwan, using the LACMs – with circular error probable (CEP) of 15-20 meters – to attack high-value point targets. Such a bombardment was estimated to last a period of ten hours.<sup>9</sup> Now, with nearly 300 launchers and some 1,600 missiles, China should, in theory, be able to double that intensity of attack with further improved CEP. At that volume of

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<sup>6</sup> "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2012" U.S. Department of Defense, p. 21, at [www.defense.gov/pubs/pdfs/2012\\_CMPR\\_Final.pdf](http://www.defense.gov/pubs/pdfs/2012_CMPR_Final.pdf).

<sup>7</sup> Shlapak, David A., et al., "A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute" RAND Monograph MG-888-SRF, 2009, p. 34, at [www.rand.org/pubs/monographs/2009/RAND\\_MG888.pdf](http://www.rand.org/pubs/monographs/2009/RAND_MG888.pdf).

<sup>8</sup> "China aiming 200 more missiles at Taiwan: MND" Taipei Times, September 4, 2012, at [www.taipetitimes.com/News/front/archives/2012/09/04/2003541913](http://www.taipetitimes.com/News/front/archives/2012/09/04/2003541913).

<sup>9</sup> "Briefing Report on the Special Procurement Budget" Taiwan Ministry of National Defense, Taipei, July 2, 2004.

sustainable firepower, the PLA would be able to attack all of Taiwan's air fields, hardened aircraft shelters (HAS), C2 facilities, radar sites, communication nodes, and critical infrastructure, as well as political targets. It is clear that China is continuing to aggressively expand and enhance this capability.

In the event of a conflict, the PLA also aims to further isolate the island by keeping the U.S. and its allied forces at bay. The canonical symbol of this strategy is the Chinese development of an anti-ship ballistic missile (ASBM). The DoD report states that in addition to its existing missile capabilities, "*China confirmed it is developing an anti-ship ballistic missile (ASBM). ... Known as the DF-21D (CSS-5 Mod 5), this missile is intended to provide the PLA the capability to attack large ships, particularly aircraft carriers, in the western Pacific Ocean.*"<sup>10</sup> The DF-21D is likely meant to primarily target American and Japanese surface ships, but psychologically it is targeted at Taiwan. China's development of the ASBM sends a clear and disturbing message to Taiwan – U.S. ships will not get to the Taiwan Strait in a timely manner; you are alone.

### **Potential Limitations**

There is no question that the ongoing Chinese missile build-up presents a substantial and growing threat to Taiwan. Still, there are some significant limitations inherent in this focus on missile capabilities, and it is important to understand both the threat and Taiwan's vulnerabilities in the proper context.

There are currently six PLA SRBM brigades deployed against Taiwan in the provinces of Fujian, Guangdong, Jiangxi, and Zhejiang. In addition, the GLCM brigades based in Jiangxi, Guangxi, and Guizhou Provinces could also cover Taiwan as needed. Each SRBM brigade is equipped with 24-36 mobile (single-missile) launchers. Based on similarities between the two organizations, each GLCM brigade probably has a similar number of ready-launch missiles (at 3 missiles per launcher). Together, these units field a combined total of some 300 launchers nominally capable of sustained salvo fire. Nevertheless, the Second Artillery Corps has not yet successfully demonstrated launching of more than 12 missiles at a time, suggesting that the maximum simultaneous volume of fire that the Chinese SRBM/LACM forces can launch against Taiwan is substantially less than the sum total of available launchers.

In addition, the number of missiles available for firing may be limited by logistics, since each brigade only possesses an authorized number of missiles at any given time. Most of the SRBMs are not normally controlled directly by the missile brigades in the Nanjing Military Region, but are believed to be stored and maintained at a centralized depot in Shangrao (northeastern Jiangxi Province), possibly with annexes in the Qimen (Anhui Province) and Leping (Fujian Province) areas. The depot stores the missiles, components, and related assemblies in hardened facilities, and uses specialized equipment to test the missiles before they are transported to the individual brigades for combat operations.<sup>11</sup>

With adequate surveillance, these organizational features of China's SRBM forces could offer meaningful operational-level warning for Taiwan. The scheme also represents a potential vulnerability to single-point

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<sup>10</sup> U.S. Department of Defense, Annual Report to Congress, p. 22.

<sup>11</sup> Stokes, Mark A. and Ian Easton, "*Evolving Aerospace Trends in the Asia-Pacific Region: Implications for Stability in the Taiwan Strait and Beyond*" The Project 2049 Institute, May 27, 2010, at [project2049.net/documents/aerospace\\_trends\\_asia\\_pacific\\_region\\_stokes\\_easton.pdf](http://project2049.net/documents/aerospace_trends_asia_pacific_region_stokes_easton.pdf).

failures, in that the operations of the Chinese missile forces are highly logistics-dependent and rely heavily on rail transportation. It would not be difficult to identify the depot locations and/or the railway transportation nodes involved – the neutralization of which could greatly disrupt Chinese missile operations, and perhaps even negatively affect a larger integrated aerospace campaign against Taiwan.

While SRBMs and LACMs do present a formidable first-strike capability, the combination of accuracy and warhead limits their real-world effectiveness against hardened or non-fixed (mobile or transportable) targets. An increasing portion of newer Chinese SRBMs and LACMs therefore now employ satellite (GPS, and/or GLONASS, and/or Beidou/Compass) guidance for terminal correction of the missile's inertial navigation unit. This helps improve their CEP to the level approaching that necessary for attacking hard-point (unhardened point targets) or semi-hardened targets with a tactically meaningful degree of confidence. However, the addition of such guidance modes could lend the missiles vulnerable to jamming.

It is also useful to examine the cumulative destructive power that China's SRBM/LACM force is actually capable of delivering. With a typical payload of not more than 500kg (1,100 lbs.), the PLA's 1,600 missiles translate into no more than 800 tons of high-explosive munitions, with CEPs of around 15 meters. This certainly represents a significant amount of ordnance if all missiles are accurately delivered to the designated targets. It is worth noting, however, that during the 1991 Gulf War, the Allied Coalition forces expended some 7,400 tons of precision-guided munitions (PGMs).<sup>12</sup> During the first five months of Operation Enduring Freedom in Afghanistan, the U.S. dropped some 6,600 JDAMs ("Joint Direct Attack Munitions," GPS-guided bombs of 500-2000 lbs. weight), including 100 deployed during one 10-minute period on October 18, 2001. In 2003, during the march towards Baghdad, the U.S. expended more than 6,500 JDAMs.<sup>13</sup>

These munitions had realized accuracy comparable to or better than current Chinese TBMs/LACMs, were delivered in substantially greater tonnage and – at times – in intensity comparable to a theoretical PLA mass missile strike on Taiwan. Yet the results, while tactically impressive, were not by themselves decisive or coercive enough to win any of the wars.

Massed missile attacks can certainly shock Taiwan, damage important military installations, and devastate other critical infrastructure. Yet PLA's offensive missile capabilities, while impressive, are likely not sufficient by themselves to bring about the effects-based destruction that the PLA envisions with its integrated coercive aerospace campaign.

The fact is that missiles, however cheaply they may be produced in China, are a costly means of delivering high-explosive payloads. U.S. experience from Desert Storm indicated that many targets had to be attacked repeatedly, with multiple rounds of munitions. For example, the average number of laser-guided bombs

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<sup>12</sup> Dudney, Robert S., ed., "Washington Watch: McPeak on the War" AirForce Magazine, Vol. 74, No. 5, May 1991, at [www.airforce-magazine.com/MagazineArchive/Pages/1991/May%201991/0591watch.aspx](http://www.airforce-magazine.com/MagazineArchive/Pages/1991/May%201991/0591watch.aspx).

<sup>13</sup> Huiss, Randy, "Proliferation of Precision Strike: Issues for Congress" Congressional Research Service Report R42539, May 14, 2012, p. 6.

(LGBs) dropped per target during Desert Storm was four, with no fewer than two LGBs dropped per target. About 20% of these targets had to be attacked with six or more LGBs, while 15% required eight or more.<sup>14</sup>

Some portion of the PLA missile attacks would have to be directed at civil government and commercial facilities, such as power generation and transmission assets and communications centers, transportation chokepoints, etc., reducing their effectiveness against Taiwan targets. That effectiveness will be further reduced if some portion of the PLA force must be directed against U.S. airbases in the region.

With the likely lethality of Chinese TBMs/LACMs under actual combat conditions in proper perspective, it should be obvious that delivering the amount of destructive payloads necessary to achieve the desired military coercive objectives by missiles alone will be cost-prohibitive. This is because long-range, precision-guided land-attack missiles, such as TBMs or LACMs, can cost 16 to 60 times as much as precision guided bombs. For example, the total cost of the approximately 2,000 tons of laser-guided bombs delivered by F-117A stealth fighters during the 1991 Gulf War amounted to about US\$146 million (NT\$4.29 billion), whereas the same weight of munitions in Tomahawk LACMs would have cost US\$4.8 billion (NT\$141.21 billion). Using the Tomahawk LACM to deliver all of the precision-guided munitions tonnage (7,400 tons) dropped in Desert Storm would have cost US\$18 billion (NT\$529.56 billion) in 1991 currency.<sup>15</sup>

At the very least, the PLA is still a very long way off from possessing a TBM/LACM force of the size and capability required to do the job single-handedly.

### ***PLA Air Force Gaining Ground***

Aircraft – being reusable and capable of carrying much larger tactical payloads – provide a much more economical means of delivering ordnance to targets, especially once enemy air defenses have been effectively suppressed. China would therefore have to rely on manned combat aircraft and repeated strike sorties to deliver the vast tonnage of munitions needed to achieve its coercive campaign goals in regards to Taiwan.

This is why, in addition to developing the most advanced theater ballistic and land attack cruise missiles in the region, China has also been focusing on modernizing and expanding the PLA Air Force (PLA-AF). According to the latest report on China from the DoD:

*China bases approximately 490 combat aircraft within unrefueled operational range of Taiwan and has the airfield capacity to expand that number by hundreds. ... The January 2011 flight test of China's next-generation fighter prototype, the J-20, highlights China's ambition to produce a fighter aircraft that incorporates stealth attributes, advanced avionics, and super cruise-capable engines.<sup>16</sup>*

<sup>14</sup> "Operation Desert Storm: Evaluation of the Air Campaign" General Accounting Office (GAO) Report NSIAD-97-134, June 12, 1997, p. 24, at [www.gao.gov/archive/1997/ns97134.pdf](http://www.gao.gov/archive/1997/ns97134.pdf).

<sup>15</sup> Hallion, Richard P., "Precision Guided Munitions and The New Era of Warfare" Air Power Studies Center, RAAF Base Fairbairn-ACT, Australia, 1995.

<sup>16</sup> U.S. Department of Defense, Annual Report to Congress, p. 24.

A recent RAND report actually estimates that the PLA has an even larger number of combat aircraft available in a Taiwan contingency, finding that the PLA-AF has up to 600 fighters that can be put in range of Taiwan. This includes modern fighter variants with capable weapons systems – FLANKERs and J-10s, for example, are armed with air-to-air missiles (AAMs) in the form of AA-12s and PL-12s, in addition to PGMs and LACMs.<sup>17</sup>

In comparison, it is obvious that Taiwan is experiencing a degradation of its air defense forces. China's rapid, sustained military modernization over the past two decades has steadily eroded Taiwan's relative capabilities.

The Second Artillery Corps and the PLA-AF also seem to be settling on concepts of operations in which SRBMs are used to “kick open the door” – i.e. suppressing all air defenses and targeting Taiwan's C4ISR systems – in an attempt to allow for follow-on attacks by aircraft armed with advanced and precise munitions that can deliver punishing blows to the island.

The development of the J-20 (a stealthy, super cruise fighter aircraft) might actually indicate that the PLA realizes that missile salvos will not by themselves compel Taiwan to surrender. It shows that the PLA-AF is preparing to contend with advanced aircraft fighting for control of Taiwan's airspace. In fact, a more capable Taiwan fighter aircraft fleet might actually force the PLA to invest scarce defense dollars into fighter aircraft rather than into SRBMs, and the former are easier for Taiwan and its partners to challenge.

### **Role of China's Air Defense System**

Engaging in combat in the skies over Taiwan is one thing, but even a formidable Taiwan Air Force (TAF) might find it difficult to bring the fight to the enemy. That is because the PLA-AF and Second Artillery Corps can pursue their coercive objectives under the cover of an expansive air defense system.

The existing Chinese surface-to-air missile (SAM) systems add an extra dimension to combat aircraft operations for TAF, and could complicate even defensive counter-air (DCA) missions over Taiwan airspace. In addition to expanding their SAM systems, China's aviation industry is developing several types of airborne early warning and control (AEW&C) aircraft, which could further complicate the tactical picture for Taiwan. Again, according to the 2012 DoD report on China:

*The PLA Air Force has continued expanding its inventory of long-range, advanced SAM systems and now possesses one of the largest such forces in the world. Over the past five years, China has acquired multiple S-300 battalions, the most advanced SAM system that Russia exports. It has also introduced the indigenously designed HQ-9.<sup>18</sup>*

China has purchased at least eight battalions of S300 PMU-2 long-range SAM systems, and may receive another eight battalions over the next few years. The PLA has also taken into service a substantial number of indigenous HQ-9 SAM systems (similar to the Russian S300PMU, at a 100+km range). A number of S300 PMU-2 and HQ-9 SAM units are already deployed along the Fujian coast, and with their 200-km range they

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<sup>17</sup> Shlapak, David A., et al., pp. 54, 85.

<sup>18</sup> U.S. Department of Defense, Annual Report to Congress, p. 24.

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could reach within a few miles of the entire Taiwan west coast. In principle, the S300 PMU-2 could even threaten aircraft operating from Hsinchu AFB in northern Taiwan immediately upon take-off. Over the next several years, China could also purchase the new Russian 400km range S-400, or develop longer-range versions of the HQ-9.

An additional area of concern is PLA-N ship-based SAMs, as their range extends farther over the island as they approach. The growing sophistication of the PRC's land- and ship- based SAMs underscores the importance of modern Radar Warning Receivers (RWRs) and other electronic countermeasures (ECMs) for Taiwan's fighters, as further discussed below.

China's air defense system plays an important role by providing a secure rear area, thereby allowing China to expand its options for coercing Taiwan. For example, in addition to bombarding Taiwan assets to bring the island to its knees, the PLA-AF could also enforce more limited air blockades and no-fly zones. By striking ports, navigation routes, and commercial airstrips, an air blockade could shut down commerce and cut off contact with the international community. For the PLA-AF, an air blockade could further isolate and strangle Taiwan, compelling it to accede to Beijing's demands. It therefore represents a means of coercion short of all-out war.<sup>19</sup> It remains questionable, however, just how well the PLA can integrate its fighters with its land- and ship-based SAM forces.

### ***The PLA and Coercion***

China is already using its aerospace and other military assets to intimidate competitors and to soften them up for negotiations. In almost every dispute with a neighbor, China uses military exercises, threats, and intimidation to try to get its way. A few recent examples of China throwing its weight around include with India, in the Yellow Sea, and in the East China Sea.

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<sup>19</sup> Schriver, Randall and Mark Stokes, p. 15.

**Table 1: Chinese Intimidation Using Aerospace Assets**

<b>India</b>	Land border disputes continue with India, and China has recently carried out four major military exercises just across the border from India in Tibet, exercises that included fighters, spy planes, and helicopters. In addition to their usefulness for training purposes, such exercises send a strong message that warns India away from intervening politically in Tibet, and demonstrates Chinese might.
<b>Yellow Sea</b>	<p>In response to a U.S.-Republic of Korea joint exercise, which itself was a response to North Korea's unprovoked murder of South Koreans, China conducted a five-day military exercise called Vanguard 2010. It took place over the central province of Henan and the eastern coastal province of Shandong, which borders the Yellow Sea.</p> <p>The PLA-AF exercise included about 100 military aircraft and 12,000 soldiers. Weapons systems involved reportedly included fighter-bombers, strike aircraft, air defenses, and helicopters. The PLA also exercised electronic warfare and information operations assets.<sup>20</sup></p>
<b>South China Sea</b>	In 2011, Japanese F-15J fighters intercepted Chinese Y-8 surveillance planes near the Diaoyutai (Senkaku) islands, in what may have been a Chinese effort to see how Tokyo would respond. Also in 2011, a Chinese State Oceanic Administration helicopter conducted a flyby of a Japanese destroyer. The incident occurred in the Shirakaba/Chunxiao gas field, where Beijing and Tokyo had previously been trying to cooperate in energy resource development. Such Chinese behavior suggests that it may have turned away from cooperation and towards a more confrontational approach. <sup>21</sup>

**Taiwan Lives with Coercion**

The very existence of the PLA's large arsenal of precision-guided missiles, 4<sup>th</sup> generation fighter aircraft, and advanced SAMs, all knitted into a robust C4ISR system, means that Taiwan and its citizens live with a proverbial gun pointed at their head on a constant basis. Despite Taiwan President Ma Ying-jeou's attempts since his election in 2008 to initiate rapprochement between Taiwan and China, ongoing PLA modernization efforts, provocative exercises, and political pressure continues unabated.

For example, in 2009 the Second Artillery Corps and the PLA-AF conducted cross-service, inter-theater, live-fire joint training exercises for the first time. It has been reported that participants included 5,000 people from four missile brigades, two aviation divisions, electronic warfare and ISR units, and radar brigades.<sup>22</sup> The

<sup>20</sup> "China air force exercises 'carry message'" BBC News, August 3, 2010, at [www.bbc.co.uk/news/world-asia-pacific-10849934](http://www.bbc.co.uk/news/world-asia-pacific-10849934). See also Lim, Louisa, "Tensions Rise As China Launches Show of Force" NPR, August 5, 2010, at [www.npr.org/templates/story/story.php?storyId=128979056](http://www.npr.org/templates/story/story.php?storyId=128979056). Cheng, Dean, "Chinese Military Exercises Remind U.S. of Need to Be Ready for High-Intensity Conflict" The Foundry, August 6, 2010, at [blog.heritage.org/2010/08/06/chinese-military-exercises-remind-u-s-of-need-to-be-ready-for-high-intensity-conflict](http://blog.heritage.org/2010/08/06/chinese-military-exercises-remind-u-s-of-need-to-be-ready-for-high-intensity-conflict).

<sup>21</sup> Hardy, James, "China, Japan Fated for Conflict?" The Diplomat, March 11, 2011, [the-diplomat.com/flashpoints-blog/2011/03/11/china-japan-destined-for-conflict](http://the-diplomat.com/flashpoints-blog/2011/03/11/china-japan-destined-for-conflict).

<sup>22</sup> "The Second Artillery Corps and the Air Force Conduct Joint Live Fire Exercises for the First Time" [translated] NetEase Military, July 19, 2009, at [war.163.com/09/0719/13/5EJBG2P00011MTO.html](http://war.163.com/09/0719/13/5EJBG2P00011MTO.html).

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exercise demonstrated the kind of joint operations that the PLA could conduct in a coercive aerospace campaign, which would include theater ballistic missiles, advanced fighters, EW, and ISR. While the exercise was conducted primarily to improve PLA joint operations, it also sent a signal to Taiwan that the PLA is becoming more lethal and that an onslaught against the island cannot be stopped.

In subsequent years – and despite significant steps forward on economic issues, such as the signing of the Economic Cooperation Framework Agreement (ECFA) in 2010 – China has continued to deploy SRBMs across the Taiwan Strait, has flight tested its new stealth J-20, and has indicated that the DF-21D ASBM is close to initial operational capability. In September of 2012, it was also reported that Chinese military forces had carried out a series of ballistic and cruise missile tests that simulated attacks on Taiwan and “*used capabilities designed to penetrate missile defenses and to hit ‘hardened’ or protected targets.*”<sup>23</sup>

The message to Taiwan is clear: Beijing will conduct economic negotiations with the island, but is sharpening its sword for battle should Taiwan fail to go far enough in talks with Beijing. The psychological effects on Taiwan are immeasurable. Only a country that faces such a threat can truly know how it affects its citizen’s daily life, how it affects domestic politics, and how to mitigate that level of insecurity. But without a doubt, Taiwan’s freedom of action is already constrained.

With China also expanding its ability to target U.S. and Japanese forces in the region, Taiwan’s isolation and sense of helplessness is growing. As Taiwan enters into negotiations with the PRC on improving cross-Strait relations, it does so from a position of relative weakness. Taiwan’s leaders know that should Beijing lose patience with diplomacy, the PLA can unleash a salvo that would cause untold destruction on the island.

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<sup>23</sup> Gertz, Bill, “*Inside the Ring: Invitation to China*” Washington Times, September 19, 2012, at [www.washingtontimes.com/news/2012/sep/19/inside-the-ring-invitation-to-china](http://www.washingtontimes.com/news/2012/sep/19/inside-the-ring-invitation-to-china).

## **COUNTERING THE THREAT**

### ***Air Defenses***

#### **Combat Air Patrol**

The most common type of mission flown by TAF in peace time is combat air patrol (CAP) in the Taiwan Strait, normally east of the so-called Taiwan Strait Meridian – an artificial center line approximately 50 miles from the Taiwan coast. This type of mission is more important than often recognized in analyses of the cross-Strait military balance, since regular patrolling reaffirms sovereignty and control over the airspace in question. Moreover, regular presence deters Chinese probing actions aimed at further compressing Taiwan's strategic depth.

The CAP flights also provide on-station aircraft ready to react to unexpected contingencies. TAF typically maintains a flight of two to four aircraft from each fighter wing on CAP stations around Taiwan at any time during daylight hours. A typical CAP sortie lasts 60-90 minutes, and, on average, each fighter wing flies about 30 CAP sorties a day. In addition, depending on the alert level, at least four aircraft are maintained at 5-minute/6-minute alert (Ready 5/Ready 6) status, with another four at 15-minute alert (Ready 15) status at each fighter base, for emergency scramble to respond to contingencies.

CAP missions constitute a critical element of the TAF's Air Sovereignty responsibilities. They provide the first line of homeland airspace defense, and serve as an important component to enable the Maritime Strike/Anti-Invasion operations by the TAF and the Taiwan Navy (TN).

CAP would also be important in wartime, beyond strictly defending Taiwan against aerial attacks. The ability to at least temporarily control certain airspace over Taiwan's littorals helps TN vessels perform their anti-shiping and anti-submarine warfare (ASW) roles in a more survivable manner, by keeping both enemy fighters and bombers (carrying standoff anti-ship missiles) away from their areas of operation. CAP would also be very meaningful in maritime blockade scenarios, where Taiwan's maritime patrol aircraft would need a secure battle space in order to conduct ASW patrols to clear sea lanes, or to hunt submarines that may be on patrol stations off Taiwan. Similarly, maintaining local air superiority would be critical to Taiwan's ability to either clear naval mines deployed by Chinese forces in a blockade of the island, or to prevent the PLA from neutralizing Taiwan's defensive minefields.

The fighter aircraft conducting these patrol missions must be at least comparable in performance and air-to-air combat capability with the likely threats. Therefore, the requirements of the CAP mission constitute one of the key operational drivers for TAF force size and capability.

#### **Defensive Counter-Air**

One of the most crucial wartime missions for TAF air defense would be conducting defensive counter-air (DCA) operations. In a major shooting war, Chinese manned air strikes would likely be preceded by initial waves of SRBM/LACM attacks focusing on Taiwan's air bases, command and control centers, radar stations,

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POL storage and handling, munitions storage facilities, and SAM sites. The intent would be to reduce – or at least temporarily paralyze – Taiwan’s air defense capability. Manned strike packages would then provide a far more efficient (and cost-effective) means of delivering the large amounts of precision ordnance necessary to systematically neutralize Taiwan’s military infrastructure.

Therefore, TAF’s most important DCA objective would be to limit the damage to air bases and C3 centers by the preemptive SRBM/LACM attack, and to work against the main raid of manned strike packages – intercepting the incoming aircraft and greatly reducing their mission effectiveness, either by destroying the raiders or by forcing them to divert from attacking their intended targets. Note that the number of targets for ballistic and standoff missiles imposes a limit on how extensively the PLA-AF would be able to focus on base closure strikes. This gets exacerbated if some portion of missiles has to be held back for potential strikes against intervening allied air bases and carrier battle groups.

Since all PLA fighters now entering service are armed with BVR air-to-air missiles (AAMs), the air defense aircraft Taiwan would scramble in response to an attack must be comparably equipped in order to have any realistic chances of successfully engaging PLA-AF raids. This highlights the need for modern RWRs to be added to the F-16A/B Block 20 upgrade, as discussed below. It also suggests that Taiwan’s F-5s, whose primary role is LIFT/OCU, have a minimal role to play in DCA due to their weaknesses in BVR combat and poor acceleration for interception. With the exception of the F-5s, however, all of Taiwan’s current frontline fighters have BVR air-to-air missile capability and carry active radar-guided, medium-range AAMs as their principal air-to-air armament. Depending on the aircraft type, TAF fighters are equipped with BVR missiles with nominal maximum ranges of 70-105km. China’s new-generation fighters are similarly armed, fielding BVR missiles with nominal ranges of 60-100km. Actual effective engagement ranges will, of course, depend on the tactical situation and launch conditions.

Taiwan must be able to launch a critical mass of BVR missile-capable, high-performance fighters in order to achieve favorable exchange ratios and desired DCA combat outcomes. This is another reason for Taiwan procuring new, modern fighters. The operational objective is to steadily attrite Chinese air assets at favorable exchange ratios, so as to disrupt the momentum for follow-on operations.

### **Maritime Strike/Anti-Invasion**

The other main wartime mission for TAF manned combat aircraft would be attacks against Chinese invasion forces, either in the form of naval surface groups underway or amphibious forces attempting to land and establish beachheads on Taiwan. China has upgraded and expanded its Army and Marine amphibious forces since the early 1990s, and this decade China is expected to build both more large amphibious assault ships and new large Russian-designed assault hovercrafts.

Sinking, damaging or disabling amphibious transports would be the most effective way of defeating a Chinese invasion attempt. Air power is the most efficient way of accomplishing that objective, and TAF has developed a reasonably effective stand-off anti-ship attack capability, with the world’s only Air-Launched Harpoon (anti-ship missile) capability onboard its F-16A/Bs. They also have a limited close-air support and precision, all-weather attack capability.

However, TAF must be able to attain and – at least temporarily – maintain a degree of local air superiority in order to permit the outbound strike package to be launched without interference from enemy activity. Here, in addition to the DCA mission requirements, it is important to have sufficient number of aircraft with the necessary payload/range capability to carry out the strikes. Since the requirements for the CAP and DCA missions are extensive – with CAP being vital for achieving air superiority over the TN area of operations, and since anti-ship strike missions require special training, this suggests that only a small part of the Taiwan fighter force might be committed to this mission, especially given Taiwan’s current issues with aircrew training.

In addition, the maritime strike and anti-invasion mission could take interdicting aircraft into range of enemy strategic SAMs. Perhaps more importantly, it would take the aircraft into range of PLA Navy (PLA-N) ship-based SAMs, which have become more numerous and sophisticated. With the advent of anti-air warfare (AAW) ships in the PLA-N, the issue of Taiwan receiving HARM missiles needs to be seriously revisited, since the application is no longer one of just targeting land-based radars. Furthermore, Taiwan’s ability to handle with PLA-N aircraft carrier operations is a new threat area that requires attention, and will necessitate close cooperation between the TAF and TN.<sup>24</sup>

### ***Passive Defenses***

A 2009 RAND study concluded that China would need less than 240 SRBMs to disable every runway at Taiwan’s main fighter bases and to destroy all TAF aircraft not protected by hardened shelters.<sup>25</sup> Similarly, the Taiwan air defense assessment that DoD presented to Congress in September 2011 argued that F-16C/Ds did not meet Taiwan’s needs due to their dependence on runways that would be vulnerable to Chinese missile attacks. This idea – that Chinese missile strikes would so quickly neutralize Taiwan’s air force that there is little reason for Taipei to field a modern fighter fleet – has become a major talking-point in Washington, D.C.

It should be noted that upgraded F-16A/B fighters must still operate from fixed runways, just like the F-16C/Ds. This means that whatever airfield-related vulnerabilities the F-16C/D suffers from would also apply to the upgraded F-16A/Bs. For that matter, it would apply to virtually every other major combat aircraft type in the current U.S. inventory, with the possible exception of the AV-8B Harrier II and the planned F-35B Short Take-Off/Vertical Landing (STOVL) designs. In addition, Taiwan is not alone in facing this particular challenge. U.S. forces in Asia, as well as the forces of many other countries in the region, are similarly vulnerable to Chinese (and North Korean) TBMs and LACMs. Elsewhere, too, countries such as Israel face similar threats. But none of these nations, particularly not the United States, would seriously consider its conventional take-off and landing (CTOL) fighters useless simply because bases such as Osan, Kadena, or Guam are susceptible to missile attacks. Nor would the U.S. hesitate to forward-deploy its air power assets merely because certain bases are poorly hardened.

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<sup>24</sup> This section adapted from “*The Balance of Air Power in the Taiwan Strait*” US-Taiwan Business Council, May 11, 2010, at [www.us-taiwan.org/reports/2010\\_may11\\_balance\\_of\\_air\\_power\\_taiwan\\_strait.pdf](http://www.us-taiwan.org/reports/2010_may11_balance_of_air_power_taiwan_strait.pdf).

<sup>25</sup> Shlapak, David A., et al., p. xv.

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The fact is that no affordable amount of passive defenses or practicable degree of hardening could completely negate the Chinese missile threat. Instead, the sensible solution would be to invest in capabilities that would enable a meaningful portion of the overall force to survive and remain operationally viable after sustained missile attacks. Such capabilities encompass not only equipment, but also doctrine and training.

Sustained Chinese missile strikes could ultimately overwhelm TAF's missile defenses, and could indeed disable many – if not all – of the runways at Taiwan's major fighter bases. However, Taiwan currently possesses one of the most well-equipped and intensively-trained runway repair capabilities in the world. Over the past decade, Taiwan has substantially increased and completely modernized its rapid runway repair (RRR) capabilities. Extensively trained repair crews, with dedicated, specialized machinery and a sufficient stock of RRR kits, have greatly improved Taiwan's ability to quickly repair damaged runways under combat conditions. The stock of RRR kits include over 350 procured in the past few years, and is anticipated to grow even further in the coming years, with Taiwan currently studying indigenous production. Over the past few years, Taiwan has also been making investments in a number of other passive defense measures, ranging from redundancy, dispersal, and camouflage/deception, to other rapid repair capabilities and hardening.

The TAF maintains two cavernous underground facilities in eastern Taiwan (Jiashan at Hualien AFB and Shizishan at Taitung AFB) with a combined shelter capacity of at least 300 fighter-sized aircraft. Taiwan has taken steps to improve hardening of select air fields, and plans are in the works to upgrade the survivability of runways at several air bases. As part of its annual exercises, Taiwan has also increased the frequency, scope, and realism of emergency fighter aircraft operations from highways (as dispersal sites). In addition, Taiwan has steadily modernized and strengthened its electromagnetic pulse (EMP) protection and its nuclear, biological and chemical defense (NBCD) capabilities, particularly at major C2 centers and other critical air defense facilities.

These passive defenses can be quite cost-effective, requiring low operating and maintenance costs, and can contribute in a meaningful way to force preservation. They increase the direct cost of attack for the enemy, by forcing it to expend additional strikes and/or weapons on a given target in order to achieve a desired battle damage objective. Passive measures such as decoys and camouflage can also increase the indirect cost of an attack, since the enemy may have to divert resources away from other strikes in order to re-attack the same target. More importantly, aircraft or munitions expended on false targets fail to achieve the enemy's mission objective, thereby contributing to disruption of the prosecution and/or tempo of the overall aerospace campaign.

Nevertheless, passive defense measures can only shoulder so much of the defensive burden. Given time to experiment with the necessary combination of technology, intelligence, tactics, and initiative, an enemy can always develop countermeasures to overcome any such passive measures. Thus purely passive defenses are most effective when utilized in a balanced force, and in conjunction with active measures and/or even counter-strike options.

### ***Active Missile Defenses***

One of the most critical missions for Taiwan's ground-based air defenses is the defense of vital assets against TBM and LACM attacks. Because Taiwan has not been permitted to develop or buy the full suite of strike and ISR capabilities that would be necessary to find and suppress the PLA's mobile missile launchers and their enabling systems, MND has generally only had the option of buying expensive missile and air defense systems.

Over the past several years, Taiwan has indeed been making substantial investments in active missile defense systems. That includes investments in battle management, command, control, communications, and intelligence (BMC3I), as well as in early-warning capabilities. Taiwan will be taking delivery of a total of nine Patriot PAC-3 missile batteries with about 400 PAC-3 interceptor missiles, providing a robust lower-tier/terminal intercept capability, and providing coverage for the majority of Taiwan's high-value government, military, industrial and infrastructure assets. In addition, Taiwan's indigenous anti-tactical ballistic missile (ATBM) -capable Tien Kung-III (TK-3) SAM system will soon be ready for production and service. With a Ku-band active seeker, maximum range of up to 300km, and maximum intercept altitude upwards of 35,000m (115,000 ft.), the TK-3 could provide a measure of capability against TBMs with up to 600km range.

However, the PAC-3s and TK-3s must be reserved for the 1200+ TBMs aimed at Taiwan, and it is impractical for the TAF to deploy its limited inventory of these costly interceptor missiles against non-TBM targets. In addition, there are not enough PAC-3 fire units and planned TK-3 batteries to provide coverage against all potential incoming LACM low altitude ingress routes. Instead, TAF relies heavily on the aging HAWK Phase III system, which has an excellent inherent capability against air-breathing targets, including against low altitude LACMs. Yet HAWK is not currently capable of being integrated, other than by voice, into Taiwan's planned air and missile defense system/C4ISR system (first phase called *Po Sheng*, now re-designated as *Shyun An*).

Taiwan is pursuing modernization of the HAWK system as a way to counter the growing LACM threat. Modernization would allow it to be integrated using both voice and data, and to be cued – with accompanying threat information – by the TAF's Surveillance Radar Program (SRP) early-warning phased array radar and its Missile Warning Centers (MWCs), and by other tactical radars via Link 16. This would significantly improve reaction time and would enable the TAF to look for, acquire, identify and effectively engage all manner of hostile air-breathing targets at wider ranges, including low flying, low cross-section CMs. Enhanced situation awareness would also allow for multiple opportunities to engage the enemy further out, increasing Probability of Kill (Pk). In addition, full coordination of ground-based missile defenses with friendly air operation would significantly increase flexibility and system availability, and would improve the safety of friendly forces.

With Taiwan steadily developing its missile defense capabilities, the number of Chinese TBMs that would actually get through to their intended targets will likely be significantly attrited, particularly during the earlier attack waves and if Taiwan is given sufficient warning of an impending attack. But under the current TAF fighter force structure, Taiwan's LACM defense is limited. Preparing TAF to mount an effective LACM defense from the air will require upgrading all existing aircraft with advanced sensors – like the AESA radar – as well as adding new aircraft with similar capabilities.

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In any scenario, however, Taiwan's SAMs will primarily assume ATBM and cruise missile defense (CMD) roles, and therefore counter-air will shoulder most of the anti-aircraft defense. This is another argument in favor of Taiwan maintaining a sizable and modern air force.

### ***Counter-Strike***

Chinese SRBMs/LACMs and long-range SAMs represent the most serious threats to Taiwan's air defenses. In particular, the portability and dispersal of the Chinese TBMs/LACMs renders the threat difficult to neutralize. In addition to the already widely perceived effective lethality of these missiles, their mobile nature lends them the appearance of an indefensible threat.

Taiwan's present anti-missile capabilities cannot effectively deal with the entirety of this challenge. But if Taiwan were to acquire an effective countermeasure against this threat category, that could significantly undermine China's coercive strategy and greatly strengthen deterrence in the region. The latter would obviously be a highly desirable strategic objective for the U.S. in Asia and the Western Pacific.

In response to the threat – and in an attempt to exploit the operational and logistics limitations of the Chinese missile setup as discussed above – Taiwan has been developing a number of indigenous weapons and capabilities that could offer the island a modicum of counter-strike capability. Indeed, the limitations of China's missile forces have formed one of the key drivers for Taiwan's pursuit of a deep-strike capability, aimed at interdicting high-value military targets within the Nanjing Military Region (MR). The target sets for a Taiwan deep-strike capability include airfields, radar stations, naval bases, C2 facilities, SRBM/LACM storage sites, fixed and transportable SAM fire units, critical logistics facilities, transportation nodes, and select energy grids.

Computer war-game simulations have shown that the rapid modernization of China's land-based air defenses would make it too costly for Taiwan to conduct interdiction strikes against heavily-defended targets in the Nanjing MR using manned aircraft alone. It is therefore not difficult to understand Taiwan's rationale for its two major counter-strike missile programs – an indigenously developed LACM known as the HF-2E, and an unnamed SRBM that has sometimes been referred to by the code name "*Di Qing*." The HF-2E is a subsonic missile with a range of 600-800 km, and the production and service delivery for this missile model began in late 2010.

Yet Taiwan is at least several years away from possessing a robust operational SRBM capability. Its current SRBM inventory consists only of a relatively small number (<100) of SAMs that were modified for surface attack roles and that date back to the Third Taiwan Strait Crisis in 1995/1996. And because the U.S. has refused to provide the capabilities necessary to neutralize the Chinese SAM threat, Taiwan is also working on or developing several other "counter-strike" systems.

For example, consistent denial by the U.S. of Taiwan's requests for the AGM-88 HARM missile has driven Taiwan to indigenously develop the air-launched TC-2A anti-radiation missile (ARM) and its associated targeting system. Similarly, Taiwan has been compelled to develop a standoff munitions dispenser for

attacking heavily-defended threats on the Chinese mainland. The weapon is similar to the U.S. AGM-154 JSOW and has GPS/INS guidance, but is heavier and has much longer range (circa 300 km) because it is powered by a small turbofan engine. Production start is scheduled in 2014. Separately, Taiwan has also been working on a long-range supersonic ramjet-powered cruise missile that is essentially an upgraded version of the HF-3. Ostensibly developed as an anti-ship cruise missile (ASCM) for use against Chinese aircraft carriers, this model also has potential land-attack applications. All these programs are difficult and costly undertakings for Taiwan.

These so-called counter-strike weapons are intended to provide basic tools that would afford Taiwan a limited interdiction/strike capability against some of the many Chinese military targets that directly threaten the island. Most importantly, they offer a measure of SEAD (suppression of enemy air defenses) capability that might afford TAF manned aircraft with at least a reasonable chance of getting through with their strike packages to within weapons release range of their targets.

### **The Lack of U.S. Support for Counter-Strike Options**

In Taiwan's case, a viable but limited offensive counter-air (OCA) or counter-strike capability could provide an essential element as part of a layered defense to the very real and potentially devastating ballistic missile and cruise missile threat from China. But the U.S. views Taiwan's efforts towards developing counter-strike capabilities as inherently destabilizing. Some argue that Taiwan should not be provided with even a limited counter-strike capability because doing so would be providing "offensive" rather than "defensive" weapons to Taiwan – counter to the instructions in the TRA. However, this argument may be undermining cross-Strait deterrence by making China's offensive deployments and coercive military strategy completely impervious to viable countermeasures.

Limited counter-strike capabilities, giving Taiwan the ability to strike mainland-based assets, could play a crucial role in complicating Beijing's strategic calculus leading up to a potential attack. If Taiwan has the capability to neutralize offensive Chinese assets, this would also force China to divert some of its defense spending away from purely offensive systems, thereby driving the PLA to invest more heavily in defensive capabilities such as providing hardening and/or defensive systems for their missile launchers, storage and support facilities, and C2 installations. Such a re-prioritizing of assets would help alleviate pressure not only on Taiwan but also on other countries in the region threatened by China's aggressive expansion of its missile capabilities – inducing on U.S. forces in the Western Pacific.

A viable but limited OCA/strike capability to counter Chinese TBM and LACM launch platforms would hypothetically require a combat aircraft with the necessary payload/range performance. The F-CK-1A/Bs and F-16A/Bs, even when fully upgraded, would still lack satisfactory range to reach viable targets. And despite the obvious value of counter-strike options, it is highly unlikely that the U.S. would sell Taiwan anything that would clearly enable it to conduct such missions against the mainland. In addition, to add an effective manned aircraft OCA capability to the TAF arsenal would likely necessitate a sizable expansion of Taiwan's air force, above and beyond that needed for existing missions. It would require a strong force of survivable aircraft able to travel long distances, only to face the PLA on their home turf and in the face of one of the largest and most

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layered missile defense systems in the world. Moreover, the effectiveness of air attacks on surface-to-surface missile (SSM) TELs has historically been very low.

Nevertheless, by neglecting to provide Taiwan with solutions for its legitimate defense requirements, the U.S. is providing a negative incentive for Taipei, offering justification for Taiwan's pursuit of long-range missile programs and for developing other counter-strike capabilities. In this sense, America's increasingly politicized and erratic support for much needed arms sales is driving Taiwan to divert its stretched defense resources towards locally developed weapon systems and capabilities. By encouraging Taiwan to turn to indigenous counter-strike programs, like Taiwan's LACM and TBM programs, the U.S. could create additional complications for itself and for U.S.-China-Taiwan relations. In contrast, by providing systems that Taiwan requires – such as new fighters and potentially even HARM missiles – the U.S. could reassert persuasive influence over Taipei's ballistic missile plans.

## **THE FIGHTER GAP**

A key finding of any objective analysis of Taiwan's air defense situation must be the shortfall in the number of front-line combat aircraft looming in the coming decade – which in this report is referred to as the Fighter Gap.

A generally accepted minimum number of operational fighter aircraft Taiwan must field at the start of hostilities, given the size of the Chinese combat aircraft fleet deployed opposite Taiwan, stands at approximately 360~400 aircraft, or roughly the present nominal force size. Over the next ten years, however, a significant portion of the TAF's aircraft will reach the end of their useful service life, and Taiwan requires additional procurement programs to retain its current capabilities.

While the scheduled upgrade program for Taiwan's existing fleet of F-16A/Bs can significantly enhance their force-multiplying capabilities, there are limits to merely including qualitative capability enhancements. Even new capabilities cannot replace or displace the essential roles that quantity and physical presence play.

A modernized fleet of 145 F-16A/Bs will still be unable to fill the numerical gap created by the confluence of the continued poor material availability and potential retirement of Taiwan's Mirage 2000 fleet, likely declining availability for its current fleet of F-CK-1A/B Indigenous Defense Fighters (IDFs), and the retirement of Taiwan's fleet of F-5s. The upgrade program itself will actually exacerbate the shortage of operationally available front-line aircraft, as the F-16A/B fighters are taken offline to undergo the upgrade work.

### ***The F-16A/B Upgrade***

On September 21, 2011, the Barack Obama Administration formally notified Congress of a Foreign Military Sales (FMS) program to upgrade Taiwan's existing fleet of 145 F-16A/B Block 20 fighters. As notified, the upgrade package was valued at US\$5.3 billion (NT\$156.38 billion), and included:

- 176 Active Electronically Scanned Array (AESA) radars
- 176 Embedded Global Positioning System Inertial Navigation Systems (GPS/INS)
- 176 ALQ-213 Electronic Warfare (EW) Management systems
- An upgrade of 82 ALQ-184 Electronic Countermeasures (ECM) pods to incorporate Digital Radio Frequency Memory (DRFM) technology, or a purchase of new ECM pods AN/ALQ-211(V)9 Airborne Integrated Defensive Electronic Warfare Suites (AIDEWS) with DRFM, or AN/ALQ-131 pods with DRFM
- 86 tactical data link terminals
- An upgrade of 28 electro-optical infrared targeting AN/AAQ-19 "Sharpshooter" pods
- 26 AN/AAQ-33 SNIPER Targeting Systems, or AN/AAQ-28 LITENING Targeting Systems
- 128 Joint Helmet Mounted Cueing Systems (JHMCS)
- 128 Night Vision Goggles
- 140 AIM-9X SIDEWINDER Missiles
- 56 AIM-9X Captive Air Training Missiles

- 5 AIM-9X Telemetry kits
- 16 GBU-31(V)1 Joint Direct Attack Munitions (JDAMs) kits
- 80 GBU-38 JDAM kits
- Dual Mode/Global Positioning System Laser-Guided Bombs (LGBs) (16 GBU-10 Enhanced PAVEWAY II or GBU-56 Laser JDAM, 80 GBU-12 Enhanced PAVEWAY II or GBU-54 Laser JDAM, 16 GBU-24 Enhanced PAVEWAY III)
- 64 CBU-105 Sensor Fused Weapons with Wind-Corrected Munition Dispensers (WCMD)
- 153 LAU-129 Launchers with missile interface
- An upgrade of 158 APX-113 Advanced Identification Friend or Foe (IFF) Combined Interrogator Transponders
- HAVE GLASS II applications

Also included in the upgrade package were: ammunition, alternate mission equipment, an engineering and design study on replacing existing F100-PW-220 engines with F100-PW-229 engines, updates of Modular Mission Computers (MMCs), cockpit multifunction displays, communication equipment, Joint Mission Planning Systems (JMPS), maintenance, construction, repair and return, aircraft tanker support, aircraft ferry services, aircraft and ground support equipment, spare and repair parts, publications and technical documentation, personnel training and training equipment, U.S. government and contractor engineering, technical, and logistics support, test equipment, site surveys, and other related elements of logistics support.

For budget purposes, Taiwan decided to split out the purchases of certain munitions and other consumables, which could be funded through separate procurement programs and be spread over a number of years. However, the core upgrades – consisting mainly of the structural, Operational Flight Program (OFP), and avionics upgrades – are funded under a US\$3.8 billion (NT\$111.79 billion) budget authorized by Taiwan's parliament in 2011. This budget includes such key sub-systems as the AESA radar and a high-speed databus MMC.

A Letter of Offer & Acceptance (LOA) was released to Taiwan in April 2012, and was signed by MND on July 13, 2012, initiating program start in 2012. The upgrade package that Taiwan finally selected in the signed LOA includes (but is not limited to):

- Airframe structural enhancements
- New landing gears (?)
- Updated OFP
- AESA radars
- New high-speed databus MMCs
- A new electrical generator
- New Environmental Control Systems (ECS)
- Interface for new cockpit displays
- Databus for the ALR-56M Radar Warning Receiver (RWR) and for the ALQ-213 EW management system

- A new Inertial Navigation Unit (INU)
- The Common Missile Warning System (CMWS)
- The Joint Helmet-Mounted Cueing System (JHMCS) coupled with the AIM-9X IR-guided AAM with high off-boresight target engagement capability
- MIDS-LVT terminals to be installed on all F-16A/Bs in the TAF inventory that have not yet been so fitted, to provide Link-16/JTIDS datalink capability (60 F-16A/Bs were already so equipped under the *Po Sheng* C4ISR program, completed in late-2009)

The contract for the upgrade program remains to be formally awarded as of mid-September 2012, although Lockheed Martin – the original manufacturer of the F-16A/Bs – is expected to be sole-sourced as the prime contractor. Competitive selection of major subsystems, which will be managed by the U.S. Air Force (USAF) on behalf of Taiwan, is not likely to take place before at least the middle of 2013.

While Lockheed Martin will develop the upgrade package, perform systems integration, and supply the upgrade kits, the actual upgrade work will be performed in Taiwan. This work will be completed by an in-country technical partner/sub-contractor, which will provide the depot facility and labor to carry out the necessary installation work. Though not yet officially selected and announced, this will most likely be the state-owned Aerospace Industrial Development Corporation (AIDC), located in Taichung in central Taiwan. The current program schedule calls for Lockheed Martin to complete two prototype aircraft in 2016, which will undergo testing at Edwards AFB in the United States before AIDC starts producing the upgraded aircraft in Taiwan in 2017.

The F-16A/B retrofit effort represents an important and necessary mid-life upgrade that will address critical structural and supportability issues. When completed, the upgrade program will help keep the Block 20 F-16A/Bs both operationally viable and materially serviceable, allowing the aircraft to continue to serve an important role in Taiwan's air defenses. The F-16A/B upgrade program also incorporates new technologies that can both provide force-multiplying capabilities and reduce operation and maintenance costs.

The prime example is the AESA radar, which will enable an upgraded F-16A/B fighter to detect, track and engage a greater number of targets at greater ranges. In comparison with the AN/APG-66(V)2 currently used by the Block 20 F-16A/Bs, the AESA radar will allow the upgraded aircraft to fully exploit the range of the AIM-120C AMRAAM missile in BVR air-to-air engagements, thereby affording Taiwan air defense fighters significantly greater "first look/first shoot/first kill" capability. This would allow TAF to maximize the effectiveness of its smaller number of platforms and air-launched weapons, offsetting some of China's quantitative superiority and retaining a measure of superiority over the PLA-AF in fighter quality.

The AESA radar will also provide a meaningful capability against low-observable and low Radar Cross Section (RCS) targets, an important consideration in view of the emergence of such next-generation Chinese threats as the J-20 stealth fighter, Unmanned Aerial Vehicles (UAVs), and advanced cruise missiles. In addition, the AESA radar should also increase operational availability and significantly reduce support costs due to its much longer mean-time between failure (MTBF) performance over the existing systems. However Taiwan reportedly

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has a history of underfunding procurement of air-to-air weapons stocks, and therefore capabilities like AESA will require adequate stockpiles to take full advantage of achievable and improved loss-exchange rates.

In all, this critical upgrade to Taiwan's existing F-16A/B fighter fleet will help improve the combat exchange rate and will substantially enhance survivability for the Taiwan Air Force.

### **The Upgrade Falls Short**

Despite the many positives of the upgrade, however, it still falls short of meeting all of Taiwan's air defense requirements. Upgrading the F-16A/Bs cannot solve all of Taiwan's manned fighter issues and cannot, by itself, alleviate the fighter gap. Some additional concerns have also emerged from the start of the upgrade program, stemming from the specific upgrades chosen by MND.

CAP in the Taiwan Strait regularly brings TAF fighters into range of the PRC's strategic SAMs, and therefore modern defenses (such as up-to-date RWRs) are particularly important for survivability. Also, among the many improvements that the PLA-AF has made over the last two decades, one of the most significant has been in increasing its BVR capabilities. Whatever fighter force Taiwan ends up fielding will have to deal not only with the current J-7 through J-11 and JH-17 fighters, but also with forthcoming 5<sup>th</sup> generation fighters such as the J-20. Foregoing the RWR update therefore seems exceedingly inadvisable, particularly since the databus is already being procured through the upgrade program.

Replacing the Block 20's existing F100-PW-220 turbofan engines (23,930-lb thrust) was originally proposed as part of the upgrade, and the Congressional Notification even included an engineering study for a power plant upgrade using the F100-PW-229 (29,160-lb thrust) engine. But Taiwan has decided not to go ahead with an engine upgrade for the F-16A/B fleet, at least for the time being, mainly out of cost considerations. The engine replacement, together with several other minor upgrade items, would have cost an additional US\$1.8 billion (NT\$52.95 billion), beyond the originally estimated US\$5.3 billion (NT\$156.38 billion) in the September 2011 Congressional Notification.

Yet upgrading the existing F100-PW-220 engine to a new, higher-thrust, and more efficient power plant would have allowed TAF to extend the useful service life of the upgraded Block 20 fleet well into the 2030s. Conversely, the existing F100-PW-220 turbofan engines are now approaching 15 years (average 4,000 hours/equivalent thermal cycles; up to 6,000+ equivalent thermal cycles on high-hours aircraft such as the F-16 Block 20s at Luke AFB) in service, and they will be almost 25 years old (with, on average, 5,000-6,000 hours/equivalent thermal cycles) by the time the F-16A/B upgrade program is completed in 2023. Upgrading the engine would also have regained maneuver performance for within visual range (WVR) engagements, which remains a possibility. I would also shorten interception times, as well as improve supportability and lower maintenance costs.

The planned upgrades will add about 600 lbs. to the Block 20 F-16A/B's empty weight, which could lead to up to a 10% performance degradation under certain mission configurations and flight conditions. The procurement of AIM-9X and JHMCS make up for the loss of some turning ability due to weight increases, but

an argument could be made for adding strengthened landing gear to the upgrade effort, especially considering the potential lengthening of overall aircraft service life.

Some enhancement to the landing gear is indeed believed to be part of the upgrade program. Taiwan's existing F-16A/B Block 20s use the "lightweight" landing gear of the F-16 Block 15, with maximum take-off gross weight of 37,500 lbs. TAF load-out practices and significantly heavier typical landing weight (mainly due to much higher level of fuel "bringback") have contributed to cracks in the landing gear of a number of Block 20 airframes. Replacing the lightweight landing gear with heavyweight landing gear (as used on Block 30 and later) would permit a significant increase in maximum takeoff gross weight. That would also allow the benefits of a potentially upgraded engine to be fully exploited, particularly in payload/range performance.

### ***The Need Remains for New Fighters***

The U.S. Department of Defense has stated that upgrading the existing F-16A/B fighter jets will be both quicker and cheaper for Taiwan than acquiring new fighters, and that the upgrade is an excellent alternative solution for meeting Taiwan's air defense needs in the coming decade. Closer examination suggests that such a calculus is not entirely correct.

As currently scheduled, the F-16A/B upgrade will take 11 years to complete, which is about double the length of time required for a new buy of F-16C/D fighters. Initial delivery for upgraded F-16A/Bs will not begin until 5-6 years from program start – again, almost twice as long as the 36-month production lead-time for new F-16C/Ds. This means that Taiwan will not be able to possess fighters capable of meeting the emergent Chinese threat until at least 2017, and then only in relatively small increments.

Because Taiwan is currently the launch customer for several key upgrade items (the structural upgrade, the new MMC, the AESA radar, etc.), non-recurring engineering (NRE) costs are also likely to be substantial. Therefore, the F-16A/B upgrade program (at US\$3.8 billion/NT\$156.38 billion, not including munitions) actually does not represent a significant cost saving over Taiwan's original plan to purchase 66 new F-16C/Ds (at an estimated cost of US\$4 billion+/NT\$117.68 billion+). Since several critical upgrades – such as new engines and the digital Radar Warning Receiver (RWR) necessitated by the adoption of an AESA radar – are not currently part of the upgrade program, additional investments can be expected in the future, particularly if the TAF should need to continue flying its Block 20 F-16s into the mid- or possibly even the late-2030s.

The F-16A/B upgrade program therefore does not necessarily compare favorably with new fighter aircraft in terms of upfront acquisition cost, operational effectiveness, and useful service life. Simply modernizing the existing fleet of 145 F-16A/Bs still fails to address the one fundamental deficiency in Taiwan's air defense – a coming shortfall in operationally available fighter aircraft. In fact, the upgrade program itself will be contributing to this fighter gap.

### **The Looming Numerical Shortfall**

According to the preliminary program schedule, the first batch of F-16A/Bs will begin their upgrade work sometime in 2016, and the first upgraded Block 20 aircraft will not be delivered to the TAF until sometime in

## ***The Looming Taiwan Fighter Gap***

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2017. Final delivery and program completion are slated for 2023, assuming no program slippage due to delays in the development and integration of major sub-systems.

Between 2016 and 2023, TAF's fleet of 145 F-16A/Bs will be rotated through an in-country depot to undergo the rather extensive upgrade work, as carried out by the prime contractor and its Taiwan-based sub-contractor/technical partner. Given that the likely technical partner will be AIDC, and given the size of the company's depot and its production line capacity, only an estimated 24 aircraft per year can pass through the upgrade facility. This means that each F-16 squadron will have to be offline for at least 12 months to undergo the retrofit work and conversion training. Taiwan is therefore likely to experience a shortfall of at least 20-30 frontline fighters for each of the 7 years of the actual upgrade work being implemented on the F-16A/B fleet.

That is also assuming no other reduction through attrition in the number of fighter aircraft in active inventory. In fact, other important drivers may actually cause the numerical gap to widen further. Without additional procurement programs, the fighter gap is also unlikely to recede even after the F-16A/B upgrade program has been concluded.

### ***Operational Rates for the TAF Fighter Fleet***

The table and figure below estimate the number of Taiwan's available fighters through this upcoming critical period. While the total numbers of fighters in the TAF inventory might seem sufficient, each of the fighter types has an operational rate that dramatically reduces the number of actual fighters available to the TAF to prosecute peacetime and wartime contingencies.

In the case of the F-16 A/Bs - Taiwan's most important fighter – it has 16 of its fighters based at Luke Air Force Base for training purposes, reducing the number of airframes in Taiwan to 129. If you then withdraw a further 24 each year after 2016 for the F-16 A/B upgrade program, it reduces the number to 105. Taiwan's F-16 A/Bs have an operational rate of approximately 70%, leaving as few as 73 F-16 A/Bs to handle actual operations during 2017-2023.

**Table 2: Estimated Fighter Numbers Through 2023**

<b>Nominal</b>			
	<b>2012</b>	<b>2018</b>	<b>2023</b>
F-16	145	121	145
Mirage	57	57	57
IDF	126	126	126
F-5	60	0	0
<b>Total</b>	<b>388</b>	<b>304</b>	<b>328</b>

<b>Estimated Available (Operational Rate)</b>			
	<b>2012</b>	<b>2018</b>	<b>2023</b>
F-16	90 (70%)	73 (70%)	96 (75%)
Mirage	42 (75%)	34 (60%)	17 (30%)
IDF	100 (80%)	100 (80%)	88 (70%)
F-5	15 (26%)	0	0
<b>Total</b>	<b>247</b>	<b>207</b>	<b>201</b>

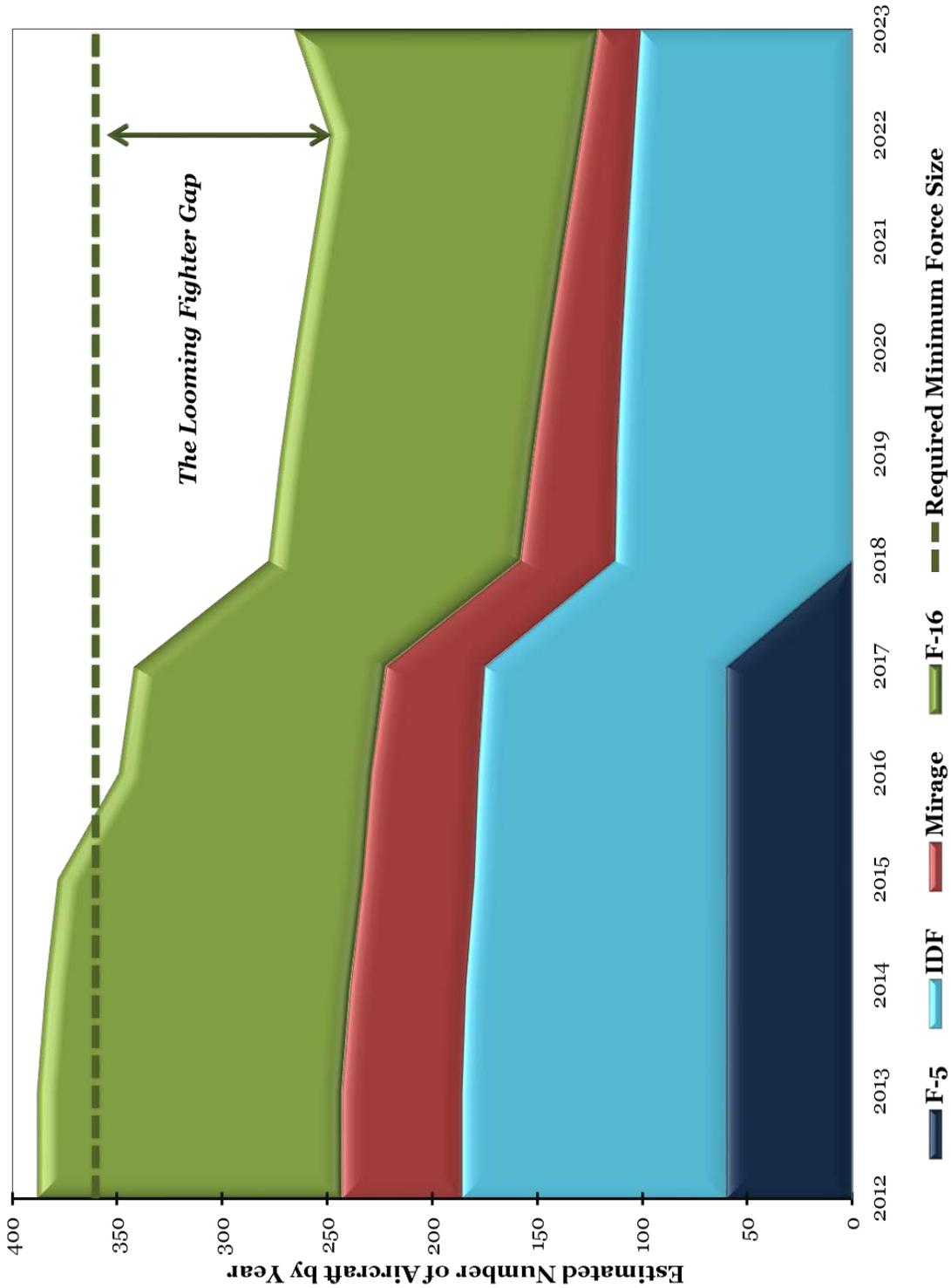
*Notes: F-16 availability figures accounts for fighters deployed at Luke AFB for training purposes, estimated availability rates, and the estimated shortfall during the upgrade process. Mirage and IDF figures based on estimated availability rates. F-5 figures based on the end of their service life in 2018, and the fact that replacement trainers are not expected to have the same emergency combat ability. 2012 operational rates are based on testimony to the LY by a Taiwan Air Force Chief of Staff.*

The strain on the numbers is significant, as fewer airplanes must fly a greater number of sorties and maintain a higher rate of use. This places greater wear and tear on the airplanes, and it also places greater strain on the pilots and the maintenance crews. Finally, the budget too will see increased demand as the TAF requests parts and maintenance additions to cover the additional use.

A similar breakdown of available operational air craft holds true for each of Taiwan’s fighter types.

As time progresses, the number of serviceable fighters in Taiwan’s inventory will continue to decrease, while the requirement for those still flying rises. Keeping just this smaller fleet in the air will have a hugely negative impact on the airplanes, their crews, the maintenance staff, and on the budget required for O&M.

**Figure 1: Estimated Fighter Numbers Through 2023**



### ***The Mirage Factor***

In late 2009 to early 2010, the TAF's current force of French Dassault Aviation Mirage 2000-5Ei/Di fighters received some much needed attention from senior military and National Security Council (NSC) leaders. This bout of attention resulted in substantial investments in spare parts and maintenance initiatives, including cooperation with Dassault and other French contractors, and led to the Mirage fleet showing substantial improvements. Availability rates rebounded to 79% in the spring of 2010 (from 58% or worse in 2009), exceeding the MND-mandated 75% minimum, and Mirage 2000 pilots were again flying 15 hours per month on the type. However, following a reported incident with a French Air Force Mirage 2000, persistent concerns about the high-pressure turbine fan blades on the M53-P2 turbofan engine led to increased fan blade inspection frequencies, thus reducing the on-airframe time of the engines – an issue that was reflected in the fleet's availability rates.

TAF has been, and will likely remain, hard-pressed to devote sufficient resources to maintaining the Mirage 2000 fleet at a high state of material readiness. It will be particularly difficult to do so given the continued tightening of the Operations & Maintenance (O&M) share of the defense budget – principally due to the increasing demand for Personnel funds to complete Taiwan's all-volunteer force transformation. With the O&M portion of Taiwan's defense budget on a generally downward trajectory over the past 5 years, and fuel and other costs rising, we have already seen pressure on funding for the Mirage 2000 fleet:

Part of the problem lies with the very high life-cycle cost of the Mirage 2000. The O&M costs for the Mirage 2000-5 are dramatically higher than for the other front-line fighter types currently in TAF service. Based on FY2010 budget figures, the O&M cost per flight hour for the Mirage 2000-5 was approximately US\$26,670 (NT\$784,630), compared with US\$5,340 (NT\$157,100) for the F-16A/B Block 20 and US\$8,340 (NT\$245,360) for the F-CK-1A/B Indigenous Defense Fighter (IDF).

Even after discounting the sharp increase in budget allocated to the Mirage fleet in FY2010 to redress the maintenance problems that had resulted from under-funding in previous years, the O&M cost per flight hour for the Mirage 2000-5 is still substantially higher than for the other aircraft types in Taiwan's inventory. MND sources indicate that the Mirage 2000-5, on average, costs about twice as much to operate and maintain as the rest of the aircraft in TAF service. While Taiwan's 57 Mirage 2000s represent only approximately one-sixth of its front-line fighter strength of the so called 4<sup>th</sup> generation of combat aircraft (F-CK-1s, F-16s, and Mirage 2000-5s), they account for nearly 60% of the TAF's O&M funding for the fighters.

The Mirage 2000's operational readiness has also been significantly impaired by the material issues surrounding its associated air-launched weapons. The 960 MICA BVR missiles and the 480 Magic 2 short-range AAMs that Taiwan purchased as part of the Mirage 2000-5 package are now 14 years old. According to the manufacturer (EADS), their solid rocket motors exceeded the factory-warranted shelf life in September, 2010. Over the past several years, Taiwan's LY has also repeatedly raised concerns about the reliability and safety of the solid rocket propellants in these missiles. In 2010, TAF ordered 280 new rocket motors, at a cost of approximately US\$16.7 million (NT\$491.3 million), to extend the service life of a portion of the Magic 2 missiles in its inventory. Yet the new motors will not be delivered until sometime in 2013. A similar Service Life Extension Program (SLEP) for the MICA active radar-guided BVR missiles is also believed to be

underway. Yet these issues highlight the difficulty and cost that Taiwan faces in having to maintain three separate and very different sets of weapons and logistical support systems for its currently active frontline fighter aircraft.

In the years ahead, as non-Personnel budget categories continue to tighten, it is difficult to envision TAF or MND allocating increasingly scarce O&M funds to ensure that the very costly Mirage 2000 fleet be maintained at consistently high availability rates. Indeed, MND has informed the Legislative Yuan (LY) that it might consider mothballing a number of Mirage 2000s to conserve O&M resources. TAF even conducted trials that involved placing up to nine Mirage 2000-5s into environmentally-controlled storage. In a 2009 estimate, the annual cost of environmentally-controlled storage for the Mirage 2000-5 fighters would only be US\$10,000 (NT\$294,200) per aircraft, whereas just to maintain a Mirage 2000-5 in airworthy condition would cost US\$470,000 (NT\$13.82 million), not counting the cost of fuel and other flight operation-dependent consumables.

It is possible that Taiwan would be best served by standing down its Mirage 2000 fleet, which would give the TAF some breathing room on O&M expenses, and allow it to redirect those funds to other programs. But while the potential cost savings could be considerable, placing frontline combat aircraft in long-term storage would significantly reduce the number of operationally available fighters for Taiwan.

With a sizable portion of its procurement budget currently committed to the F-16A/B upgrade program, TAF is now even less likely to be willing and able to make a meaningful investment in upgrades for the Mirage 2000 fleet or even just to address its supportability issues. Given increasingly scarce budgetary resources and the high cost of maintaining the aircraft and systems as they age past mid-life, material readiness and the number of operationally-available Mirage fighters can be expected to decline steadily in the coming years.

By the time the F-16A/B fleet begins its actual upgrade work in the 2016/2017 timeframe, the number of operationally viable Mirage 2000-5 aircraft will have significantly declined to well below the current nominal strength of 57. If by then the material readiness rate of the Mirage 2000-5 fleet should again fall to the level experienced in 2009 (at 58%), that alone would translate into an effective decrease of 24 operationally-available fighter aircraft.

Lastly, the true irony of the Mirage 2000 is that, while TAF and MND are fully aware of the life-cycle cost and affordability issues associated with this aircraft, the lack of a suitable – and, more importantly, obtainable – replacement aircraft has made the operational availability of the Mirage 2000 fleet one of the key factors driving the requirement for additional fighters.

### ***Impact on Training and Pilot Quality***

How and when the fighter gap is to be filled will also have implications for other major efforts that affect Taiwan's air defenses, in particular training and flight experience.

It is obvious that U.S. indecision and unwillingness to provide Taiwan with the additional fighter aircraft it urgently needs is causing significant and unnecessary dislocations in Taiwan's plans to modernize its training

systems. As the number of operationally-available frontline aircraft steadily declines after 2016/2017, this will not only widen the quantitative gap but would also further compress the already marginal qualitative edge that Taiwan has enjoyed in the past. The quality of pilot training and extensive experience represent a critical component of Taiwan's prior qualitative advantage, and now this is being squandered.

### **F-5 LIFT Retirement**

One important factor that will influence the operational viability of Taiwan's fighter force is the status and ultimate fate of its fleet of F-5E/Fs, which are now principally used in the Lead-In Fighter Training (LIFT) role with the 737<sup>th</sup> Taiwan Fighter Wing Operational Conversion Unit (OCU), based in Taitung. The ultimate fate of the F-5s will have an impact on the fighter gap problem, as it potentially leads to a need for concurrent programs to upgrade existing F-16s, procure new fighters, and acquire new trainers, while also increasing the overall air force O&M budget – a tall order. There are also questions about the extent to which Taiwan expects to continue employing its future LIFT assets in an emergency combat role, although more than likely they will.

TAF's surviving F-5s are largely what remains of the final batch of 60 F-5E/Fs that the United States sold to Taiwan during the Reagan Administration in 1982. The most recent of these, an F-5F with tail number 5416, was completed in December of 1986. Plagued by structural issues and by problems with the horizontal stabilizers and the vertical tail, the F-5Fs in particular have been experiencing poor availability rates in recent years, and are slated to be phased out. This could result in a decrease of another 60 aircraft from the active inventory during the critical 2017-2023 time period.

TAF has been examining a number of possible solutions for replacing the F-5 in the LIFT/OCU role, including the purchase of a new advanced jet trainer (KAI T-50 Golden Eagle or Aermacchi M-346), which would replace Taiwan's current advanced jet trainer (the indigenously-produced AT-3) as well as the F-5s. There is an urgent need for such replacement aircraft to accurately emulate the performance and systems capabilities of modern aircraft, which the F-5s are not well suited to do. However, a combined buy of up to 120 new advanced trainer/LIFT fighters would not only precipitate a major restructuring of Taiwan's current 3-tiered training system, but would also be quite costly overall. According to MND estimates, such a program could cost as much as US\$2.67 billion (NT\$78.55 billion).

TAF had also studied converting approximately one wing of (un-upgraded) F-CK-1A/B fighters into a LIFT variant. However, this option was envisaged as part of a successful acquisition of an additional wing of first-line fighters in the form of 66 new F-16C/D aircraft. Because the F-CK-1A/B (IDF) is basically a lightweight air defense-oriented aircraft designed with very low fuel fraction (<25%), its operational value is severely restricted due to limited payload/range capability and endurance. For this reason, TAF would much prefer to convert some of its F-CK-1A/Bs to the LIFT/OCU role, if a more suitable fighter (like the F-16C/D) could be acquired to supplant its un-upgraded F-CK-1A/Bs on the front line.

It's unclear just how appropriate converting F-CK-1s to LIFT would be, particularly as most of the Taiwan IDF fleet consists of single-seat models not well suited to the training role. It is a reasonable move only because the likelihood of buying a current-generation LIFT, including from Korea (whose FA-50 would be a good

replacement), is pretty slim due to PRC opposition. Other options might be surplus T-38C, or perhaps a restart of the IDF line that comprises or includes a LIFT variant.

Understandably, Taiwan has been quite reluctant to invest heavily in the MLU for the remaining 56 F-CK-1A/Bs that belong to the 427<sup>th</sup> Taiwan Fighter Wing based at CCK AFB in Taichung, as it would yield only a very marginal improvement in capability. An upgrade for this second batch of F-CK-1A/Bs was originally scheduled for program start in 2013, with completion in 2017, at a cost of US\$534 million (NT\$15.71 billion). The persistent U.S. Government refusal to formally consider Taiwan's request for new F-16C/Ds may now force MND to support this clearly ineffective investment, despite the collateral budget impact from the F-16A/B upgrade program.

In this context, the U.S. failure to live up to its legally-mandated obligations will force Taiwan to pursue a weapon system acquisition solution that does not adequately address Taiwan's pressing defense requirements. In other words, the U.S. would, by the nature of its action (or inaction), be squandering Taiwan's already very limited defense resources.

Taiwan can, in principle, elect to extend the useful life of its F-5s and AT-3 trainers through SLEPs, in order to postpone a costly new investment in a completely new training system. But even a limited structural work and avionics update – which would be needed to extend the service life of Taiwan's F-5E/F in the LIFT role to beyond 2018 – would require a substantial investment. TAF does not deem such an investment to be cost-effective, given the remaining useful life and very limited tactical value of the upgraded F-5s.

Persistent delays in the fighter acquisition process (especially when caused by U.S. inaction or indecision) make coherent, coordinated force modernization planning virtually impossible, which is why – as of the fall of 2012 – the MDN has not yet made decisions with respect to either procuring a new advanced LIFT aircraft or to seriously plan for a SLEP for the F-5s. TAF has been holding off on making LIFT program decisions pending a resolution to the fighter situation, and now the options for a satisfactory solution are quickly narrowing.

Senior TAF officers have warned that as the obsolete F-5s continue to deteriorate, and as serviceability further declines, operational conversion training for new pilots will increasingly have to be passed off to the fighter wings and combat squadrons (now referred to as "groups" in TAF parlance). The combat units, with their focus on operational missions and lack of dedicated training assets and expertise, are unlikely to be able to provide the type of training regime needed to produce pilots of the desired quality. Nor could the units provide the sort of environment that would allow pilots to maintain their proficiency.

To illustrate the effect that a shortage of operationally-available aircraft in the combat squadrons could have on pilot proficiency and operational readiness, we need only to recall the TAF's experience with the Mirage 2000s, as discussed above. In 2009, when the fleet's average availability rate was only 58% – far below the 75% peacetime standard mandated by MND – TAF Mirage pilots flew as few as 6 hours per month and in total averaged only 8 hours per month for the entire year – which certainly adversely affected proficiency. Despite major investments in a "get well" maintenance initiative, the average for 2010 was only about 10 hours per month – a third less than the 15 hours per month mandated by the MND, and less even than the minimum of 12 hours

## ***The Looming Taiwan Fighter Gap***

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that PLA-AF pilots have been logging in new-generation fighters like the Su-27SK, Su-30, and J-10. In terms of training objectives, TAF Mirage 2000s achieved a mere 37% of its assigned objectives (flight hours) in 2009, and only managed to reach 53% in 2010.

If not properly corrected in the near term, TAF's quantitative deficiency will inevitably also result in a serious qualitative deficiency, especially with respect to pilot skill and operational experience. The loss of such critical qualitative edge would almost certainly be irreversible, particularly given China's very aggressive modernization of its air force and naval aviation capabilities, with steady yet significant improvements in aircraft, weapons, C4ISR, logistics, and doctrine, as well as training.



**MEETING TAIWAN'S AIR DEFENSE REQUIREMENTS**

Taiwan has a clear and present need for additional fighter aircraft in order to plug the gap in frontline combat aircraft strength that will develop within the next 5 to 10 years.

Taiwan has examined several alternatives for making up this shortfall, including the acquisition of surplus U.S. F-15s and F-16s as interim fighters. If Taiwan should decide to go this route, these planes could be expected to see a long period of service with TAF. Because Taiwan does not have ready access to international markets for advanced combat aircraft, whatever fighter TAF now procures must still have sufficient structural life remaining and viable growth/upgrade paths to allow the aircraft to remain operational well beyond 2025. As such, fighter aircraft retired from active U.S. inventory would be poorly suited, given their generally high airframe hours and poor physical condition. With higher expected O&M costs due to their age and condition, it would not be a cost-effective solution for Taiwan. In addition, the lower availability rates expected for the older airframes and systems would require purchasing a larger number of such aircraft in order to maintain an operationally-usable force size.

It is also conceivable that Taiwan would attempt to develop and produce its own next-generation fighter. Yet Taiwan would still need U.S. technical assistance for such a program, and the U.S. would have to supply the aircraft with advanced mission equipment. This co-production model was utilized in the 1980s with the IDF program, and the conceptual proposal for a follow-on program to the IDF (featuring a stealth configuration, thrust-vectoring engine nozzles, STOL capability, AESA radar, and advanced mission avionics) was submitted by AIDC to Taiwan's Executive Yuan (EY) in 2007. But the IDF took ten years to develop, and the very long lead time and large investment required for such a program – not to mention the very significant development risks that type of project could entail – clearly renders it an option of last resort. Furthermore, the U.S. would be unlikely to support such a program, given its ongoing reluctance to transfer 5<sup>th</sup> generation fighter technology even to close allies.

Reinvigorating Taiwan's native fighter industry would be in the interests of the U.S., mainly because it is far easier politically to provide technical assistance, systems, and parts than it is to provide finished weapon systems. Nevertheless, an alternative solution – such as licensed production in Taiwan of current-generation F-16s – would be more practical than going the new development route, and would additionally provide Taiwan with enduring replacement and upgrade capabilities.

It is clear, however, that in the near term the looming fighter gap cannot satisfactorily be addressed by such interim measures, nor by programs that could take up to a decade to get off the ground. The best solution is for the U.S. to sell Taiwan a sufficient number of new-built fighters, which would have the necessary useful service life, required performance, and manageable life-cycle cost.

Taiwan needs an aircraft that combines the aerodynamic performance, mission avionics, and BVR air-to-air missile capabilities mandated by the Combat Air Patrol (CAP) and Defensive Counter Air (DCA) missions, with the payload/range performance required for the Maritime Strike/Anti-Invasion missions. The ideal candidate fighter should also be theoretically capable of conducting limited interdiction or strike missions against critical threats in the Nanjing MR, as needed. The aircraft type needs to be supportable beyond 2030, have reasonably

## ***The Looming Taiwan Fighter Gap***

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low operations and maintenance costs, and not require substantial investment in new logistical infrastructure. Perhaps most importantly, this fighter must be eligible for export to Taiwan in the near term, and/or be of a type that has previously been supplied to Taiwan.

Based on these criteria, the F-16C/D appears to be the aircraft that would best meet Taiwan's requirements.

The F-16C/Ds performance and capabilities readily satisfy TAF's operational requirements. Logistically, the fighter is backed by the U.S. Air Force and has a large user base around the world – thus supportability is ensured for many years to come. The F-16 has previously been sold to Taiwan, with 150 Block 20 F-16A/Bs approved in 1992, and this fact offers a precedent that could mitigate some of the political sensitivities surrounding the U.S. releasing a new advanced weapon system for export to Taiwan.

In addition, the F-16C/Ds acquisition and life-cycle costs have been deemed acceptable by Taiwan, which already approved the budget needed to purchase up to 66 of these aircraft as early as in 2007. Taiwan's LY has additionally stated that despite the pressures on the defense budget, including the costly ongoing upgrades to Taiwan's existing fleet of F-16A/Bs, Taiwan is willing and able to find the funds needed to go ahead with a procurement program for new fighters. Finally, and not the least important, the F-16C/D is currently still in production.

### ***The F-35 Conundrum***

There are some in Taiwan defense and policy circles who are advocating that TAF leapfrog the F-16C/D, instead pursuing U.S. release of the next-generation F-35 fighter – specifically the F-35B STOVL version. The F-35B, it is argued, would best suit Taiwan's air defense needs, and would also be much more future-proof and could give Taiwan access to next-generation U.S. technology and doctrine.

The problem here is that the F-35 represents an even more politically sensitive weapon system than the F-16C/D. Beijing have repeatedly stated that a U.S. sale of new F-16C/Ds to Taiwan would constitute "crossing the red line." Since two successive U.S. administrations have been reluctant to sell Taiwan additional F-16s, it is extremely difficult to imagine the rationale justifying the U.S. release of the even more advanced F-35s in the foreseeable future.

In more practical terms, the F-35 has yet to enter service even with the U.S. and major NATO allies. Even if the U.S. should decide to approve such a sale, current orders and delivery schedules would suggest that the earliest Taiwan might receive F-35 production delivery would be sometime between 2020 and 2025. The F-35 also carries a price tag much higher than that of the F-16C/Ds.

It should be patently obvious that even should the U.S. approve the system for export release to Taiwan – which is extremely unlikely – the F-35 still does not represent a solution for the TAF's air defense modernization requirements in the near term. In any event, Taiwan will not be able to afford the F-35 in sufficient quantities to provide an operational capability significant enough to plug the impending fighter gap.

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### **A POLITICAL DILEMMA**

Since 2006, Taiwan has been seeking U.S. approval to purchase 66 new F-16C/D Block 50/52 fighters to augment its current fighter fleet. Officially, the U.S. government is still reviewing the requirement, even though Taiwan has been repeatedly discouraged from formally submitting the Letter of Request (LOR) for the fighters. The upgrade package for Taiwan's existing fleet of 145 F-16A/Bs that was notified to Congress in September of 2011 is generally seen as the "consolation price" awarded to Taiwan *in lieu* of the new fighters.

The window for Taiwan to purchase new-build F-16s is narrowing rapidly. One of the last pending contracts to buy new F-16s has delivery slated for some time in 2016. Given the 36-month manufacturing lead time, the production line may actually be forced to close before a decision can be made to sell new F-16s to Taiwan. Should the U.S. government decide to finally move forward and approve the sale of new F-16C/Ds, that decision would therefore have to come sometime in the near term.

During the past several years, Taipei has repeatedly and vocally requested these fighters. Meanwhile, Washington's concerns about reactions by Beijing to such a sale have hampered any progress on the issue.

### ***The Effect of Chinese Coercion in Washington***

In a perverse turn of events, China has turned its provocative Second Artillery Corps and PLA-AF deployments into a political advantage in Washington, D.C. The PLA is the primary cause of instability across the Taiwan Strait, yet rather than its actions mobilizing support for an increase in Taiwan's air power, PLA deployments are having the opposite effect.

In U.S. policymaking circles, a troubling argument has gained traction: selling any more fighter aircraft to Taiwan is pointless, because the PLA could obliterate Taiwan's air force on the ground.

As discussed above, all aircraft within range of China's missile forces are threatened. Threats to fixed-wing aircraft have existed since the advent of air power, and the answer to this challenge has always been to deploy sufficient numbers of aircraft, to disperse them, to harden bases, and to invest in other means of survivability. The fact is that no one has suggested that South Korea or Japan give up on having an air force, but in the case of Taiwan that is more or less the argument. China has therefore achieved an important policy objective without having to actually conduct an air campaign – Taiwan has a diminished air force because of political decisions in Washington, D.C.

The PRC has thus undermined the intent of both the TRA and the Six Assurances, and Beijing has succeeded in turning the arms sales process on its head. Under the Six Assurances, U.S. arms sales decisions were to be made based solely on Taiwan's military needs, and the assessment of those needs were to be based on China's military posture. It was always a given that China would protest such U.S. arms sales, and indeed they continue to do so. But the U.S. answer was supposed to be that it was in China's power to end arms sales, starting with the PRC ending its threatening military posture against Taiwan. This policy was made clear three decades ago and – at least in principle – it has not changed.

In a confidential presidential directive issued in August of 1982, President Ronald Reagan asserted the following (emphasis added):

*In short, the U.S. willingness to reduce its arms sales to Taiwan is conditioned absolutely upon the continued commitment of China to the peaceful solution of the Taiwan-PRC differences. It should be clearly understood that the linkage between these two matters is a **permanent imperative** of U.S. foreign policy.*

*In addition, it is essential that the quantity and quality of the arms provided Taiwan be **conditioned entirely** on the threat posed by the PRC. Both in quantitative and qualitative terms, Taiwan's defense capability relative to that of the PRC will be maintained.<sup>26</sup>*

Yet through years of threats, demarches, and relentless diplomatic pressure, China has now insinuated itself into U.S. policymaking on arm sales to Taiwan. In an ironic turn – one that President Reagan likely did not anticipate – China's growing military threat to the island is now used to justify America's refusal to sell Taiwan the arms it needs to counter that threat.

For China, this has been a particularly successful tactic to counter the proposed sale of much-needed additional fighter aircraft to Taiwan. In May of 2011, as the latest arms sale decision was in its final stages, General Chen Bingde, Chief of the General Staff of the PLA, warned that U.S. arms sales to Taiwan would damage U.S.-China relations, and especially military to military relations. At a joint press conference with Admiral Mike Mullen, Chen indicated that the extent of the damage would be based on the relative strength of the capability being released to Taiwan, saying "As to how bad the impact will be, it would depend on the nature of the weapons sold to Taiwan."<sup>27</sup>

By September 2011, the U.S. had apparently decided against the sale of F-16 C/Ds to Taiwan. It is almost certain that Chinese officials repeated Chen's words in discussions with their U.S. counterparts, and the net effect of China's warnings was the sale of less capability than Taiwan needs.

It appears that when it comes to China and Taiwan arms sales, the U.S. is actually rewarding undesirable behavior. The U.S. is denying Taipei the weapons and capabilities essential to the island's legitimate defense, in part because Beijing – which continues to take a threatening military posture despite cross-Strait rapprochement since 2008 – considers such sales "unacceptable." The U.S. refusal to provide Taiwan with these urgently-needed new fighters merely reinforces Beijing's belief that threats and coercion work, against Washington as well as against Taipei.

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<sup>26</sup> Lilley, James and Jeffrey Lilley, "China Hands: Nine Decades of Adventure, Espionage, and Diplomacy in Asia" New York, PublicAffairs, 2004, p. 248.

<sup>27</sup> "Arms sales to Taiwan damage US-China ties: Chen" Agence France Presse, May 18, 2011, at [www.google.com/hostednews/afp/article/ALeqM5gjS52CTOLhPQad0rWhE1DfI3wV3Q](http://www.google.com/hostednews/afp/article/ALeqM5gjS52CTOLhPQad0rWhE1DfI3wV3Q). See also Chase, Michael S., "Strong Indignation, but Limited Retribution: China's Response to U.S. Arms Sales to Taiwan" China Brief, October 14, 2011, at [www.jamestown.org/uploads/media/cb\\_11\\_52.pdf](http://www.jamestown.org/uploads/media/cb_11_52.pdf).

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It is in the interest of the United States and our allies to see China reduce its aggressive deployment of offensive and power-projection military capabilities. The U.S.'s self-imposed restrictions on defense sales to Taiwan therefore highlight a serious contradiction in U.S. policy, and a failure to adequately support our strategic objectives in the region.

### ***Congressional Support***

The lack of Executive Branch support for selling F-16C/Ds to Taiwan has lasted through two administrations. At the same time, however, there has been strong and continuing support by Congress for the sale. This is evidence for the longstanding bi-partisan recognition of the state of the military threat facing Taiwan, and for congressional support for the timely, concrete steps needed to assist Taiwan in meeting its legitimate defense needs. The F-16C/D issue in particular seems to have galvanized support for Taiwan arms sales in Congress.

For example, in May 2011, a letter sponsored by Senators Robert Menendez and James Inhofe, and signed by 43 other Senators, was sent to President Barack Obama urging his administration to *"move quickly to notify Congress of the sale of 66 F-16C/D aircraft that Taiwan needs in order to modernize its air force."* The letter stated that *"without new fighter aircraft and upgrades to its existing fleet of F-16s, Taiwan will be dangerously exposed to Chinese military threats, aggression and provocation, which pose significant national security implications for the United States."*

In July of 2011, a deal was reached between Secretary of State Hillary Clinton and Senator John Cornyn, whereby the Obama Administration agreed to a decision on the F-16 sale, as well as to deliver to Congress the long delayed Taiwan Airpower Report, by October 1, 2011. On the basis of this agreement, Senator Cornyn lifted his hold on the nomination of William Burns as the Deputy Secretary of State. In early August, 2011, another letter was sent by Capitol Hill to the White House urging President Obama to sell advanced fighters to Taiwan in accordance with the TRA. The appeal was sponsored by Representatives Shelley Berkley, Gerry Connolly, Mario Diaz-Balart, and Phil Gingrey, but it was also signed by a total of 181 members of the House of Representatives. The letter was followed about a week later by the release of the Price & Availability (P&A) data for the F-16A/B upgrade program to Taiwan. Both these actions seem to have directly contributed to the Congressional Notification for the F-16A/B upgrade package submitted on September 21, 2011.

Since the fall of 2011, we have continued to see persistent Congressional pressure to acknowledge and address the escalating Chinese military threat facing Taiwan, both by individual members of Congress and through such legislative initiatives as the Taiwan Airpower Modernization Act (S.1539 and HR.2992). These efforts yielded some dividends in late April of 2012. In response to Senator Cornyn's hold on the nomination of Mark Lippert as Assistant Secretary of Defense for Asian & Pacific Affairs, the White House issued a letter addressing concerns over Taiwan arms sales and, in particular, addressing Taipei's longstanding request to purchase new F-16C/D aircraft.

The letter included a commitment on a forthcoming *"near-term course of action"* on how to address Taiwan's fighter shortfall, and included language that seemed to revisit selling new U.S.-made fighter aircraft to Taiwan. In addition, the letter asserted that the new Assistant Secretary would play a lead role in the U.S. efforts to address Taiwan's fighter gap. The language in this White House letter differed significantly from the original

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Administration response to Senator Cornyn's concerns, where – in a February 15 letter, the U.S. Department of Defense had asserted that "*we believe the F-16 A/B upgrade effectively meets Taiwan's current needs.*" In response to the White House letter, Senator Cornyn lifted his hold on the Senate confirmation of Mr. Lippert, who was promptly confirmed. Senator Cornyn has vowed, however, that he would continue to press the administration until it sells new fighter aircraft to Taiwan.

### ***What Will It Take?***

Taiwan's requirement for additional fighters has been widely acknowledged both in Taiwan and in the U.S. Taiwan President Ma Ying-jeou himself has made numerous public requests for the fighters, and the Obama Administration acknowledged the need for new aircraft in its May 27, 2012 letter to Senator Cornyn. The campaign of Mitt Romney, the Republican candidate for President in the U.S. elections this fall, has also called for the release of additional fighters to bolster Taiwan's deterrent capability.

The requirement does indeed seem clear, but the question becomes what it will take to move forward? There are many different factors at play influencing the sale of new fighter jets to Taiwan, and the same can be said when it comes to how each of these three leaders approach the issue.

If President Obama is reelected, he is unlikely to move quickly to address this issue without further prodding from Congress. While the May White House letter to Senator Cornyn clearly stated that the sale of new aircraft was a part of the solution for Taiwan's present predicament, it is likely that the letter was primarily intended as a key to releasing Cornyn's hold on Mark Lippert. The F-16 A/B upgrade program was also green-lighted only after the hold was lifted on William Burns for the position of Deputy Secretary of the U.S. Department of State. In all likelihood, a second Obama administration will also require ongoing Congressional pressure in order to encourage it to support Taiwan's air force modernization.

Should the American people elect Mitt Romney on November 6, it is possible that he will move swiftly to address this long overlooked issue, moving forward to accept the Letter of Request (LOR) from Taiwan for as many as 66 new F-16 C/Ds. There does not appear to be any internal opposition on this matter within his current national security team, and if it moves quickly and decisively he should be able to outmaneuver those forces in Washington and in Beijing who oppose the sale on political grounds. His team would have to move quickly, however, because those opposed to such a sale would likely swiftly marshal to place the issue back into its present quagmire.

In Taiwan, President Ma already won his reelection fight, but he does have an ongoing challenge with the island's weak economy. Taiwan's economy is still too dependent on exports to foreign markets, and the likelihood of domestic reform to spur growth is low. The government budget is therefore going to remain tight, which presents a tremendous challenge. Ma's commitment— made in 2007 – of spending no less than 3% of Taiwan's GDP for defense has never been met, and it is also not likely to be during his remaining tenure in office.

Despite the budget concerns, however, the leadership in Taiwan's Legislative Yuan (LY) – including Speaker Wang Jin-Pyng and Foreign Affairs & National Defense Committee (FANDC) leader Lin Yu-fang – has

repeatedly stated that if the United States is prepared to release new fighters, the LY is prepared to budget the funds.

Since his reelection in early 2012, President Ma has yet to publicly call for the F-16 C/D sale, but that is more likely a timing issue rather than reflecting a change in position. He cannot back away from the sale, as it would undermine his credibility with the Taiwan military. Doing so could also do serious damage to Taiwan's relations on Capitol Hill where a number of senior Senators and Representatives have gone to significant lengths to move the issue this far down the road. Nevertheless, we are unlikely to see the sort of political push from Ma that we have seen from 2008-2012, as the Ma government is likely to await signals from Washington D.C. and respond accordingly.

Ultimately, it falls to the U.S. to move forward on this issue. If Romney wins, look for relatively quick action of some kind in early 2013. If Obama wins, look for Congress to resume its leadership on this issue and press his administration to act. If the sale is to proceed, it will take political will from both the President and Congress, along with budgetary support from Taiwan.



## CONCLUSIONS

Taiwan's primary defense challenge consists of an integrated and well-orchestrated air campaign, with PLA efforts combining ballistic and cruise missile attacks and attacks by manned strike aircraft and unmanned aerial vehicles, in concert with information/electronic warfare and attacks by special operations forces.

The United States does not take lightly the prospect of coming to Taiwan's aid in the event of an attack – unprovoked or otherwise. Therefore, as Taiwan and the U.S. gauge how to best discourage and/or repel a Chinese attack in the Taiwan Strait, Taiwan will require the means to do so other than those capabilities inherent in its domestic counter-strike missile capabilities.

Purchasing new F-16 C/D from the U.S. appears to be the best and only viable way for Taiwan to maintain a modern and capable fleet of fighter aircraft in sufficient numbers. The question then becomes whether or not it makes sense for the U.S. to sell Taiwan those new F-16 C/Ds? Is it true that Chinese missile strikes would so quickly neutralize Taiwan's air forces that there is little reason for Taiwan to field a modern fighter fleet?

This argument against the F-16C/D sale is problematic –it essentially relies on two faulty assumptions. First, it assumes that a massive PLA aerospace campaign is the only scenario in which Taiwan would see a need to deploy fighters. In fact, fighter aircraft would have a role to play on multiple rungs of the escalation ladder. For example, Taiwan fighter jets patrol the Taiwan Strait on a daily basis. Not too infrequently, the TAF scrambles fighters to intercept PLA-AF pilots that stray across the Taiwan Strait meridian – a line halfway between Taiwan and the coast of the PRC. Taipei cannot reasonably continue to ask its fighter pilots to conduct such engagements if Taiwan does not upgrade its air fleet to match Beijing's. As PLA-AF fighters grow increasingly fast and increasingly stealthy, they will be ever more capable of invading Taiwan's airspace at will – unless Taiwan can follow suit with similar aircraft acquisitions.

Other, more stressing scenarios also require Taiwan to possess air power of its own. For example, should Beijing decide to institute a naval blockade to coerce Taiwan into a settlement (which Beijing might hope would be perceived as less escalatory than other options), fighter aircraft could carry out maritime strike missions, and TAF fighters could also provide air cover for Taiwan naval operations.

It is true that a modernized TAF would also play an important role in resisting a coercive aerospace campaign. But this is where the second faulty assumption comes in. Turns out it might not be so easy for China's Second Artillery Corps to suppress the TAF in the opening salvos of a missile campaign. With ongoing investments in underground airbases, hardening, decoys, runway repair capabilities, and innovative training (taking off from and landing on highways), Taiwan's air force could wait out the early days of a conflict and be ready to take to the skies once China committed its strike aircraft to the fight. Many small groups of fighters dispersed across the island could stretch China's ISR capabilities, and force the PLA to expend more missiles on more runways and roadways while providing potential opportunities to harass Chinese assets in the waters and skies around Taiwan.

To be effective in these and other missions, the TAF requires a modern air combat capability. And as noted earlier, by modernizing its air force Taiwan can force the PLA to divert investment from its missile force into

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other, perhaps less cost-effective capabilities. In particular, the PLA would be likely to increase investment in tactical fighter aircraft and relevant munitions, land-based air defenses, (naval) fleet air defense, and C4ISR. In forcing the PLA to adopt such a defense acquisition strategy, Beijing would dilute its coercive aerospace power.

For Taiwan, the United States is the only viable source of the modern fighters that they require. The U.S. has a legal and moral obligation to meet that need, and there does not seem to be sufficient cause to disregard those obligations. Beijing might follow through on the threat to downgrade relations with Washington in response to a sale of new fighter jets to Taiwan. Yet this too is a threat given significantly too much credence in Washington, as it also rests on what would appear to be another faulty assumption – that China will jeopardize all of its equities with Washington over a single bilateral issue, no matter how symbolically important.

If the U.S. decides, for political or for any other reasons, to forego assisting Taiwan in closing its fighter gap, that could also have substantial repercussions for U.S. forces in the region. If the U.S. government permits Taiwan's defensive capability to degrade, the U.S. itself will have to step in to augment Taiwan's air defenses in the event of an attack by China – a prospect that U.S. air defense forces do not relish. The U.S. ability to project air combat capabilities from Kadena or Guam, from a small number of aircraft carriers, or from even remoter bases is already limited. The high sortie-generation rates that would be required to conduct an air defense of Taiwan in the early stages of an invasion would tax those air combat capabilities to the limit – unless the U.S. cares to consider options such as basing its own fighters on Taiwan itself.

The ongoing tensions in the South China Sea/East China Sea highlight the need for all countries involved, including Taiwan, to have robust air forces capable of dealing with all manner of contingencies. The tensions in the Diaoyutai (Senkaku) islands may not involve all-out war, but they do involve a raised sortie rate. With the number of fighters that it can field at any given time dwindling – with potentially only as many as 73 F-16A/Bs operational at any given time during the upgrade program – Taiwan's air forces will not be able to manage heightened air operations during times of such raised tensions.

Taiwan's looming fighter gap isn't just a destabilizing issue in the Taiwan Strait. It is also a problem for a U.S. that already finds itself heavily involved in the numerous security issues in North Asia, and which should be loath to add a further burden on its already strained military – particularly when supporting the TAF by approving the sale of new fighters would go a long way towards addressing the issue.

**APPENDIX**

**Acronyms**

AAM	Air-to-Air Missile
AAW	Anti-Air Warfare
AESA	Active Electronically Scanned Array (Radar)
AEW&C	Airborne Early Warning & Control
AFB	Air Force Base
AIDEWS	Airborne Integrated Defensive Electronic Warfare Suites
AIDC	Aerospace Industrial Development Corporation
AMRAAM	Advanced Medium Range Air-to-Air Missile
ARM	Anti-Radiation Missile
ASBM	Anti-Ship Ballistic Missile
ASCM	Anti-Ship Cruise Missile
ASW	Anti-Submarine Warfare
ATBM	Anti-Tactical Ballistic Missile
BMC3I	Battle Management, Command, Control Communications, Intelligence
BVR	Beyond Visual Range
C2	Command & Control
C3	Command, Control & Communications
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance
CAP	Combat Air Patrol
CEP	Circular Error Probable
CM	Cruise Missile
CMD	Cruise Missile Defense
CMWS	Common Missile Warning System
CTOL	Conventional Take-Off and Landing
DCA	Defensive Counter-Air
DoD	Department of Defense
DRFM	Digital Radio Frequency Memory
ECM	Electronic Countermeasures
ECFA	Economic Cooperation Framework Agreement
ECS	Environmental Control System
EMP	Electromagnetic Pulse
EW	Electronic Warfare
EY	Executive Yuan

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FANDC	Foreign Affairs & National Defense Committee
FMS	Foreign Military Sales
GLCM	Ground-Launched Cruise Missile
GLONASS	Global Navigation Satellite System/Globalnaya Navigatsionnaya Sputnikovaya Sistema
GPS	Global Positioning System
HARM	High-speed Anti-Radiation Missile
HAS	Hardened Aircraft Shelter
IDF	Indigenous Defense Fighter (FC-K-1A/B)
IFF	Identification, Friend or Foe
INS	Inertial Navigation System
INU	Inertial Navigation Unit
IR	Infrared
ISR	Intelligence, Surveillance & Reconnaissance
IW	Information Warfare
JDAM	Joint Direct Attack Munition
JHMCS	Joint Helmet-Mounted Cueing System
JMPS	Joint Mission Planning System
JSOW	Joint Standoff Weapon
JTIDS	Joint Tactical Information Distribution System
LACM	Land Attack Cruise Missile
LGB	Laser-Guided Bomb
LIFT	Lead-In Fighter Training
LOA	Letter of Offer & Acceptance
LOR	Letter of Request
LY	Legislative Yuan
MICA	Missile d'Interception et de Combat Aérien, "Interception & Aerial Combat Missile"
MIDS-LVT	Multifunctional Information Distribution System – Low Volume Terminal
MLU	Mid-Life Update/Upgrade
MMC	Modular Mission Computer
MND	Ministry of National Defense (Taiwan)
MR	Military Region
MTBF	Mean Time Between Failure
MWC	Missile Warning Center

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NATO	North Atlantic Treaty Organization
NBCD	Nuclear, Biological & Chemical Defense
OCA	Offensive Counter-Air
OCU	Operational Conversion Unit
OFP	Operational Flight Program
O&M	Operations & Maintenance
P&A	Price & Availability
PAC	Patriot Advanced Capability
PGM	Precision-Guided Munitions
Pk	Probability of Kill
PLA	People's Liberation Army
PLA-AF	People's Liberation Army – Air Force
PLA-N	People's Liberation Army – Navy
POL	Petroleum, Oils, & Lubricants
PRC	People's Republic of China
RCS	Radar Cross-Section
RRR	Rapid Runway Repair
RWR	Radar Warning Receiver
SAM	Surface to Air Missile
SEAD	Suppression of Enemy Air Defenses
SLEP	Service Life Extension Program
SRBM	Short-Range Ballistic Missile
SRP	Surveillance Radar Program
SSM	Surface-to-Surface Missile
STOL	Short Take-Off & Landing
STOVL	Short Take-Off/Vertical Landing
TAF	Taiwan Air Force
TBM	Tactical Ballistic Missile
TEL	Transporter-Erector-Launcher
TIFA	Trade & Investment Framework Agreement
TN	Taiwan Navy
TRA	Taiwan Relations Act
UAV	Unmanned Aerial Vehicle
USAF	United States Air Force

WCMD                      Wind-Corrected Munition Dispenser  
WVR                        Within Visual Range

## **Glossary**

### **4th Generation Fighter**

4th generation fighters are those produced and deployed between the 1980s and the 2000s. They include fighters such as the F-16, the F-16, the Mirage 2000, the Chinese-made J-10, and the Russian-built Su-27 and MiG-31.

### **5th Generation Fighter**

A fighter aircraft classification that encompasses the most advanced generation of fighter aircraft as of 2012. They are designed to incorporate numerous technological advances, such as stealth technology, for advantages over predecessor aircraft.

### **AA-12 “Adder”**

The NATO designation for the Russian R-77 (nicknamed “Amraamski”), the AA-12 is an active radar-homing, all-aspect, all-weather, medium-range air-to-air missile. The missile is comparable in general performance to the U.S. AIM-120A/B (AMRAAM), but with a longer range and a heavier warhead. It is considered to be inferior to the AIM-120 in missile seeker technology and countermeasure capability.

### **Active Electronically-Scanned Array (AESA) Radar**

Also known as active phased-array radar, an AESA is a radar system whose transmitter and receiver components spread their broadcasts out across a band of frequencies, making it difficult to detect over background noise. This allows the ships and aircraft that use them to broadcast powerful radar signals while remaining stealthy.

### **AEGIS MK-7 Combat System**

Aegis, “shield” in Latin, is the U.S. Navy’s modern surface combat system. Aegis was designed and developed as a complete system, capable of engaging in simultaneous warfare on several fronts. An advanced, automatic detect and track, multi-function phased-array radar, coupled with a computer-based command and decision element, provides the core of the Aegis combat system. This interface makes Aegis capable of simultaneous operation against multi-mission threats: anti-air, anti-surface, and anti-submarine warfare. Its weapons can be trained on targets at a wide range of altitudes, and is capable of engaging anti-ship cruise missiles and manned aircraft flying in all speed ranges from subsonic to supersonic. There are currently only four ship classes in the world equipped with the AEGIS Combat System, including the US Navy’s TICONDEROGA and ARLEIGH BURKE-class vessels.

### **Aerospace Industrial Development Corporation (AIDC)**

The Aerospace Industrial Development Corporation is Taiwan's premier military and commercial aircraft and parts manufacturer. AIDC worked together with CSIST and Lockheed Martin to design and produce 130 Indigenous Defense Fighter (IDF) aircraft. In addition, AIDC has produced PL-1 Primary Trainers, T-CH-1 Basic Trainers, AT-3 Advanced Jet Trainers, UH-1 H Helicopters, and F-5A/E Fighters.

### **AGM-88C HARM (High-speed Anti-Radiation Missile)**

The AGM-88 HARM is a supersonic air-to-surface tactical missile designed to seek and destroy enemy radar-equipped air defense systems. The HARM missile has a terminal homing capability that provides a launch and

leave capability for the launch aircraft. Additional features include the high speed, low smoke, rocket motor and the seeker sensitivity that enables the missile to easily attack sidelobes and backlobes of an emitter.

**AGM-154 Joint Standoff Weapon (JSOW)**

A standardized medium-range precision guided air-to-surface glide weapon with standoff capabilities. Produced by Raytheon, the weapon is designed to engage targets outside the range of standard anti-aircraft defenses.

**AIM-9 “Sidewinder”**

A supersonic, heat-seeking, air-to-air missile whose main components are an active infrared homing guidance system, an optical target detector, a high-explosive warhead, and a rocket motor. The M model has improved capability against infrared countermeasures and features modifications that increase its ability to locate and lock-on to a target and decrease the chance of missile detection. The AIM-9X are air-to-air, short range, heat seeking missiles with improved range, speed, and maneuverability, greatly enhanced acquisition ranges, IR countermeasures, and provides compatibility with helmet-mounted displays. The AIM-9X Captive Air Training Missile contains an inert warhead and rocket motor, for training purposes. AIM-9X Telemetry Kits contain a working motor, but includes telemetry instrumentation instead of a warhead.

**AIM-120 “Slammer” AMRAAM**

The AMRAAM (Advanced Medium Range Air-to-Air Missile) is a medium-range air weapon with multi-shot capability. Initially guided by an inertial reference unit and a microcomputer, receiving target coordinate updates from the radar system of the launch aircraft in mid-course, in the terminal phase of flight the missile's active radar seeker guides it independently, without further reliance on the launching aircraft. The C-7 variant features a new guidance section that gives it an improved ability to detect, track and home in on current and emerging air threats, even when operating in an environment of severe electrical interference.

**Airborne Early-Warning & Control (AEW&C)**

An airborne radar system designed to detect aircraft. Typically, AEW&C-enabled aircraft operate at high altitudes and large, external radar dishes enable onboard operators to view and distinguish between friendly and hostile aircraft hundreds of miles away. The system is used offensively to direct fighters to their target locations, and defensively to counter attacks. Older terms for AEW&C include Airborne Early Warning (AEW) and Airborne Warning and Control System (AWACS).

**Air-Breathing Engines**

Term used for jet engines that require outside air to operate. In contrast to rocket engines, whose fuel is self-contained, for air-breathing engines outside air is brought in, mixed with fuel, and then ignited to create thrust.

**Air-to-Air Missile (AAM)**

Guided missiles that are fired from one aircraft to destroy another. They are typically powered by rocket engines that use either solid or liquid fuel. AAMs are categorized as short range (SRAAM), medium range (MRAAM), or long range (LRAAM) and are typically outfitted with infrared or radar guidance systems.

**AN/AAR-57 Common Missile Warning System (CMWS)**

The AN/AAR-57 CMWS is the detection component of a suite of countermeasures developed to increase survivability of current generation combat, airlift and special operations aircraft against the threat posed by

infrared guided missiles. The system provides automatic passive missile detection, threat detection, crew warnings, false alarm suppression and cues for other on-board countermeasures equipment such as chaff and IR decoy flare dispenser systems.

**AN/AAQ-19 “Sharpshooter”**

An international derivative version of the AN/AAQ-14 targeting pod, part of the LANTIRN (Low Altitude Navigation and Targeting InfraRed for Night) system. It works in conjunction with the AN/AAQ-20 Pathfinder navigation pod. The Sharpshooter is not compatible with the AGM-65 Maverick air-to-ground missile, and it also has does not have some air-to-air features of the AN/AAQ-14.

**AN/AAQ-28 “Litening”**

A precision targeting pod system, originally developed for the Israeli Air Force. The targeting pod uses cameras, several sensors, a laser designator and a laser rangefinder to simplify target detection and recognition, and to permit attack of targets with precision-guided weapons.

**AN/AAQ-33 “Sniper”**

The AAQ-33 is the Air Force’s new Advanced Targeting Pod (ATP), intended to allow for positive identification, automatic tracking, and laser designation of targets. It features a Forward Looking Infrared (FLIR) camera receiver and a high-resolution TV camera, allowing for observation and tracking in daylight and in low light/no light. It offers a 3-5 time increase in detection range over legacy systems.

**AN/APG-66**

The AN/APG-66 radar is a solid-state medium range (up to 150 km) pulse-doppler radar originally designed by the Westinghouse Electric Corporation (now Northrop Grumman) for use in the F-16 Fighting Falcon. The AN/APG-66(V)2 is an upgraded version with a new signal processor, higher output power, improved reliability, and increased clutter/jamming environment range.

**AN/ALQ-131 Electronic Countermeasures (ECM) Pod**

The ALQ-131 is an external electronic countermeasures (ECM) pod designed to provide protection against radar directed weapons. The pod, which has a modular design for multiple frequency band capability, provides self-protection jamming against pulse Doppler or CW jamming threats. It can quickly be re-programmed against changing threats.

**AN/ALQ-184 Electronic Countermeasures (ECM) Pod**

The ALQ-184 is a self-protect electronic countermeasures (ECM) pod that protects aircraft against radio frequency threats in a complex radar guided threat environment by selectively directing high power jamming against multiple emitters. The system provides instantaneous RF signal processing, and features a high sensitivity multi-beam receiver, continuous wave, pulse, and pulse Doppler signal processing.

**AN/ALQ-211 Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS)**

A system designed to counter pulse, pulse-Doppler, continuous-wave and mono-pulse radar threats. It provides warning and active jamming, and can undertake countermeasures to defeat radar guided air defense artillery threat systems such as surface-to-air-missiles and anti-aircraft artillery. The AN/ALQ-211(V)9 is a Pod-mounted version of the jammer.

**AN/ALQ-213 Electronic Warfare Management System (EWMS)**

Produced by Danish company Terma, the ALQ-213 was originally developed for the F-16 in close cooperation with the Royal Danish Air Force. Now a generic system used in many different aircraft, it reduces pilot workload by integrating, managing, and controlling a variety of electronic warfare subsystems, while also interfacing with the core avionics systems.

**AN/APX-113 Advanced Identification Friend or Foe (IFF) Transponder**

A versatile identification friend or foe (IFF) system specifically developed for the F-16 Falcon. A Combined Interrogator/Transponder (CIT), it includes mode S Elementary and Enhanced Surveillance capability, and has an AIMS-approved mode 5 growth path.

**AN/FPS-115 Radar**

A long-range, phased array, Land-Based Fixed Defense Radar (LBFDR) designed to detect and characterize ballistic missiles. Manufactured by Raytheon, the radar system is capable of detecting and monitoring a great number of targets consistent with a massive attack. The system must rapidly discriminate between vehicle types, calculating their launch and impact points in addition to the scheduling, data processing and communications requirements. The operation is entirely automatic, requiring operators only for monitoring, maintenance and as a final check on the validity of warnings.

**Anti-Air Warfare (AAW)**

Term used to describe the actions required to destroy, or reduce to an acceptable level, enemy air and missile threats. AAW includes the use of interceptors, bombers, anti-aircraft guns, surface-to-air and air-to-air missiles, electronic attack, and destruction of the air or missile threat both before and after it is launched.

**Anti-Ship Ballistic Missile**

An anti-ship ballistic missile (ASBM) is a military quasiballistic missile system designed to hit a warship at sea.

**Anti-Submarine Warfare (ASW)**

Anti-submarine warfare involves the use of submarines, aircraft, and surface ships (commonly destroyers), to locate, track, and then either damage or destroy submarines and submarine port facilities, production facilities, and supply routes. Anti-submarine warfare also involves communication interception, decryption, and disinformation.

**Anti-Tactical Ballistic Missile (ATBM)**

A system or part of a system for defending against tactical ballistic missile strikes. ATBM components can include a number of sub-systems such as satellites, radars, C2, missiles, and warning arrangements.

**AT-3 Trainer**

The AT-3 is an advanced jet trainer operated by the Taiwan Air Force. The Aerospace Industrial Development Corporation (AIDC) manufactured sixty of the aircraft between 1984 and 1990. The aircraft is called "Tzu Chiang", which translated into English roughly means "to gain strength independent from others."

**AV-8B Harrier**

The McDonnell Douglas (now Boeing) AV-8B Harrier II is a second-generation vertical/short takeoff and landing (V/STOL) ground-attack aircraft.

### **Ballistic Missile, Conventional**

A ballistic missile is a missile with a prescribed course governed by the laws of ballistics. A conventional ballistic missile is a ballistic missile with a non-nuclear, conventional warhead.

### **Ballistic Missile, Tactical**

A ballistic missile is a missile with a prescribed course governed by the laws of ballistics. A tactical ballistic missile is designed for short-range battlefield use of typically less than 300 km, filling the gap between conventional artillery and long range missiles. Usually mobile to ensure survivability and quick deployment, tactical ballistic missiles can carry a variety of warheads to target enemy facilities, assembly areas, artillery, and other targets behind the front lines.

### **Beidou Navigation System**

Short for “beidou daohang xitong,” this term may refer to either one or both generations of a Chinese-built satellite navigation system. The first version, also called BeiDou-1, consists of three navigation satellites and has been offering limited services, mainly to customers in China, since 2000. The second version, BeiDou-2 or “Compass,” is a system of 35 navigation satellites that is still under construction. It began limited operations in China in December 2011, with 10 satellites in use. Plans are for the system beginning to serve the Asia-Pacific region by 2012, expanding to a global customer base upon its completion in 2020.

### **Beyond Visual Range (BVR)**

Refers to the use of missiles to kill an airborne foe at distances outside the range of the human eye, generally outside about 15 miles. Radars and missiles are necessary in BVR combat, and command, control and positive identification are crucial to avoid hitting the wrong target.

### **BMC3I**

BMC3I stands for Battle Management, Command, Control, Communications and Intelligence, and represents a system through which a military manages Theater Missile Defense (TMD). BMC3I is built upon the existing command and control (C2) structure, and adds communications linking TMD C2 nodes, weapons, and sensors, as well as TMD interfaces to intelligence systems and other supporting capabilities.

### **Burns, William J.**

The current Deputy Secretary of State and the highest ranked Foreign Service Officer in the United States. He holds doctorate degrees in International Relations from Oxford University, and several honorary doctorates. After entering the Foreign Service in 1982, he has served in numerous positions, including on the staff of the National Security Council, as Ambassador to Jordan, Ambassador to Russia, and as Under Secretary of State for Political Affairs. He holds the rank of Career Ambassador, the highest personal rank that can be awarded to a U.S. Foreign Service officer.

### **C4ISR**

C4ISR refers to systems that are part of the Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance domain. The C4ISR domain is one of four domains for which the Joint Technical Architecture specifies a domain annex. C4ISR is defined in the Joint Technical Architecture (JTA, Defense Information Systems Agency, 1999) as those systems that:

- Support properly designated commanders in the exercise of authority and direction over assigned and attached forces across the range of military operations.

- Collect, process, integrate, analyze, evaluate, or interpret available information concerning foreign countries or areas.
- Systematically observe aerospace, surface or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means.
- Obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area.

**Carrier Battle Group**

Also known as Carrier Strike Group. This describes an aircraft carrier and its escorting fleet. The primary power of the group stems from the largest of its members, the aircraft carrier, but its ultimate safety relies on the protection from those surrounding it. Also typically included are two guided-missile cruisers (offensive ships), two destroyers (defensive ships), one frigate (anti-submarine defense), two submarines (offensive and defensive minded), and one supply ship (carrying fuel, food, and ammunition).

**CBU-97/CBU-105 Sensor Fuzed Weapon (SFW)**

The CBU-97 is a smart munition, non-guided, anti-armor Cluster Bomb Unit developed by Textron. It consists of a tactical munition dispenser that contains 10 BLU-108 submunitions. Each submunition contains four sensor-fused projectiles called Skeets. These detect targets, such as tanks, armored personnel carriers, trucks and other support vehicles, and fire an explosively formed penetrator at the target. When equipped with the Wind Corrected Munitions Dispenser (WDMD) guidance tail kit – an inertial guidance package that corrects for wind drift when dropped from higher altitudes – it is designated the CBU-105.

**Chiang, Ching-kuo**

Chiang Ching-kuo was the son of Chiang Kai-shek and held numerous posts in the Kuomintang (KMT) and in the Taiwan government. He succeeded his father to power, serving as Premier from 1972 to 1978 and as President from 1978 until his death in 1988. Under his tenure, the government, although still authoritarian, became much more open and tolerant of political dissent. Towards the end of his tenure, Chiang relaxed government controls on the press and speech and put native Taiwanese in positions of power, including his successor Lee Teng-hui.

**Ching Chuan Kang Air Force Base (CCK AFB)**

Ching Chuan Kang Air Force Base is the home of Taiwan's 3rd Tactical Fighter Wing, with three squadrons of Ching-kou (IDF) air-defense /attack fighters. The base is located along Taiwan's west coast, near the city of Taichung.

**Circular Error Probable (CEP)**

In the military science of ballistics, circular error probable (CEP) is an intuitive measure of a weapon system's accuracy. It is defined as a circle, centered about the mean, whose boundary is expected to include 50% of the population within it.

**Combat Air Patrol (CAP)**

An aircraft patrol provided over an objective area, over the force protected, over the critical area of a combat zone, or over an air defense area for the purpose of intercepting and destroying hostile aircraft before they reach their target(s).

**Command and Control (C2)**

Command and control (C2) is the exercise of authority and direction by a properly designated commander over assigned and attached forces in support of accomplishing the mission.

**Congressional Notification**

Formal declaration to Congress of proposed foreign arms sales, managed by the Defense Security Cooperation Agency (DSCA).

**Conventional Take-Off and Landing (CTOL)**

Normal runways where conventionally powered airplanes take-off and land.

**Conventional Fighters**

Fighters that use conventional power sources and runways to take-off and land as well as operate air operations.

**Cornyn, John**

A Republican serving as the senior Senator from Texas. Before being elected to the U.S. Senate in 2002, he served as an attorney, as a district judge, and as a member of the Texas Supreme Court. From 1999-2002, Cornyn was the Texas Attorney General. He has been a strong supporter of U.S. arms sales to Taiwan.

**Cruise Missile Defense (CMD)**

An integrated and joint architecture to protect against the threat of a cruise missile attack. Components include the capability to detect and track missiles after launch, interceptors to destroy missiles in-flight, and an effective battle management and communications network.

**Dassault Aviation**

Dassault Aviation is a French manufacturer of civil and military aircraft and is a subsidiary of the Dassault Group.

**Defensive Counter-Air (DCA)**

The term for all defensive measures, both active and passive, designed to detect, identify, intercept, and destroy or negate enemy forces attempting to penetrate or attack through friendly airspace.

**De Jure**

From Latin, meaning in accordance with law, or by legal right. Contrast with *de facto*.

**Démarche**

A formal diplomatic representation of the official position, views, or wishes on a given subject from one government to another government. The U.S. government defines it as a request or intercession with a foreign official, including as a protest about a specific government policy or action.

**DF-21**

The DF-21 (CSS-5), or Dongfeng-21 (“East Wind 21”), is a two-stage, solid-propellant, single-warhead medium-range ballistic missile (MRBM) originally deployed in the early 1990:s. China’s first solid-fuel land-based missile, it has a maximum range of 1,700 km, and a payload of 600 kg. The DF-21C (CSS-5 Mod-3) is a modified version of the missile with improved navigation and targeting, making it better suitable for precision-strike missions. The latest DF-21D was said to be the world’s first anti-ship ballistic missile (ASBM). The DF-21 has also been developed into a space-capable anti-satellite/anti-missile weapon carrier.

**Diaoyutai (Senkaku) Islands**

The Diaoyutai (name in Chinese) or Senkaku (name in Japanese) Islands are a group of disputed, uninhabited islands that are claimed by Japan, the Republic of China (Taiwan) and the People's Republic of China (PRC). The islands are located roughly northeast of Taiwan, due west of Okinawa, and due north of the end of the Ryukyu Islands in the East China Sea.

**Digital Radio Frequency Memory (DRFM)**

An electronic method for digitally capturing and retransmitting an RF signal. DRFM technology is typically used in radar jamming, although applications in cellular communications are becoming more common.

**EADS**

The European Aeronautic Defense and Space Company N.V. (EADS) is a global pan-European aerospace and defense corporation and a leading defense and military contractor worldwide.

**East China Sea**

The East China Sea is a marginal sea located east of China.

**Economic Cooperation Framework Agreement (ECFA)**

The ECFA is a preferential trade agreement between Taiwan and China. The agreement, originally called a Comprehensive Economic Cooperation Agreement (CECA), is intended to maintain Taiwan's economic competitiveness in the world market and allow Taiwan to avoid marginalization. The agreement permits the free flow of many goods, services, and capital between Taiwan and China, but key items such as agricultural produce are exempt, largely as a concession to Taiwan farmers. Discussions on the ECFA formally started in early 2010, and it was signed on June 29, 2010.

**Edwards Air Base**

Edwards Air Force Base (IATA: EDW, ICAO: KEDW, FAA LID: EDW) is a United States Air Force base located on the border of Kern County, Los Angeles County, and San Bernardino County, California, in the Antelope Valley.

**Electronic Countermeasures (ECM)**

A subsection of electronic warfare that includes any sort of electrical or electronic device designed to trick or deceive radar, sonar, or other detection systems like infrared and laser. It may be used both offensively and defensively in any method to deny targeting information to an enemy. The system may make many separate targets appear to the enemy, or make the real target appear to disappear or move about randomly.

**Electromagnetic Pulse (EMP)**

A burst of electromagnetic radiation that results from an explosion (especially a nuclear explosion) or a suddenly fluctuating magnetic field. The resulting electric and magnetic fields may couple with electrical/electronic systems to produce damaging current and voltage surges.

**Environmental Control System (ECS)**

ECS in an aircraft provide air supply, thermal control, and cabin pressurization. It also includes avionics cooling, smoke detection, and fire suppression systems.

**Executive Yuan (EY)**

The Executive Yuan is the highest administrative body of Taiwan. It consists of the heads of each of the major government Ministries, the heads of commissions, and the Ministers without portfolio. The Executive Yuan President (i.e. the Premier) is appointed by the President, and subsequent Ministerial appointments are made by the President in consultation with the Premier.

**Electronic Warfare (EW)**

Refers to a warfare action using the electromagnetic spectrum (EMS) or directed energy (DE) to control the EMS or to attack an enemy. The purpose of EW is to deny the opponent advantages in the EMS and ensure the friendly unimpeded access to the EM spectrum portion of the information environment. EW can be applied from air, sea, land, and space by manned and unmanned systems.

**F100-PW-220**

The F100 family of fighter aircraft engines is a high-pressure-ratio engine originally developed for the F-15. The PW-220 model, introduced in 1986, includes digital electronics allowing for precision control, advanced maintenance features, and added extended durability and reliability of metallurgical and heat-transfer advances.

**F100-PW-229**

The F100 family of fighter aircraft engines is a high-pressure-ratio engine originally developed for the F-15. The PW-229 model, introduced in 1989, incorporates modern turbine materials, cooling management techniques, compressor aerodynamics, and electronic controls.

**F-117A**

The Lockheed F-117 Nighthawk was a single-seat, twin-engine stealth ground-attack aircraft formerly operated by the United States Air Force (USAF).

**F-5 “Tiger II/Freedom Fighter/Peace Tiger 6”**

The F-5 is a small, light supersonic fighter aircraft that is easy-to-fly and simple to maintain. Never a part of the USAF tactical forces, it has been used to represent a hostile fighter in simulated combat, as some of the characteristics of the F-5 resemble those of the Soviet-built MIG-21. In the 1970’s, AIDC cooperated with the U.S. designers to manufacture F-5E for the Taiwan Air Force, and AIDC imitated the F5-E to produce F-5F. “Peace Tiger” was the name for the license production program.

**F-15 “Eagle”**

An all-weather, extremely maneuverable, tactical fighter designed so one person can safely and effectively gain and maintain air superiority in aerial combat. The Eagle's air superiority is achieved through a mixture of maneuverability and acceleration, range, weapons and avionics, with electronic systems and weaponry to detect, acquire, track, and attack enemy aircraft.

**F-16 “Fighting Falcon”**

The Fighting Falcon is a highly maneuverable, lightweight fighter aircraft flown in large numbers by the U.S. Air Force and by many other countries. More than 4,000 F-16s have been produced, in over 110 different versions (designated by “block” numbers and letters). Highly versatile and maneuverable, the F-16 is a very popular multi-role fighter.

In 1992, Taiwan acquired 145 F-16A/B fighters, Block 20, from the U.S. The Block 20 version is an Operational Capability Upgrade for Taiwan that feature an improved AN/APG-66(V)3 radar, a carriage of AGM-45 Shrike, AGM-84 Harpoon, AGM-88 HARM, and Low Altitude Navigation and Targeting Infrared for Night (LANTIRN). The computers onboard Block 20 are significantly improved in comparison to that of the earlier versions, with the overall processing speed increased 740 times and the overall memory storage increased 180 times in comparison to that of Block 15 OCU. The two-seat F-16B was intended for training but retained combat capabilities. The second additional seat was achieved through fuel load reduction, which also reduced the F-16B's combat range. In 2011, Taiwan began the process of modernizing its existing fleet of F-16 A/B fighters through an FMS program, a process that will see upgraded avionics and other improvements made between 2012 and approximately 2023.

The F-16 C/D variants requested by Taiwan beginning in 2006 are single/two-place fighters, incorporating built-in structural and wiring provisions and systems architecture that permit expansion of the multi-role flexibility to perform precision strike, night attack, and beyond-visual-range (BVR) interceptor missions.

### **F-35 JSF (Joint Strike Fighter)**

The F-35 is the result of the Defense Department's Joint Strike Fighter (JSF) program, seeking to build a multi-role fighter optimized for air-to-ground combat but with secondary air-to-air capability. The JSF is designed to meet the needs of the Air Force, Navy, Marine Corps and U.S. allies, with improved survivability, precision engagement capability, and reduced life cycle costs. Using many technologies developed for the F-22, the F-35 capitalizes on commonality and modularity to maximize affordability. The F-35B variant – produced for the United States Marine Corps – will feature a Short Take Off/Vertical Landing capability (STOVL).

### **F-CK-1A/B “Ching-kuo” Indigenous Defense Fighter (IDF)**

The Ching-kuo, also known as the Indigenous Defense Fighter (IDF), is a fighter aircraft produced by the Aerospace Industrial Development Corporation (AIDC) for the Taiwan Air Force along the same general lines as the F-16 Fighting Falcon. It was named in honor of late Taiwan President Chiang Ching-kuo.

### **Foreign Affairs and National Defense Committee (FANDC)**

A Legislative Yuan committee that is the result of the merging of the National Defense and Foreign Affairs Committees after the 2008 LY elections. The committee is responsible for foreign relations, overseas Chinese affairs, national defense, intelligence/national security, and veterans' affairs.

### **Foreign Military Sales (FMS)**

A program for government-to-government purchases of weapons and other defense articles, defense services, and military training. A foreign military buying weapons through the FMS program does not deal directly with the company that makes an item. Instead, the U.S. Defense Department serves as an intermediary, usually handling procurement, logistics, and delivery and often providing product support and training. The Defense Security Cooperation Agency (DSCA) is the focal point for U.S. FMS programs.

### **Fujian Province**

Fujian province is situated on the coast of southeastern China. Since 1949, Fujian has been split between two separate governments: the vast majority of Fujian province is governed by the People's Republic of China, while a number of offshore islands are governed by Taiwan.

### **Global Navigation Satellite System (GLONASS)**

GLONASS is a global navigation satellite system operated by Russia. It is a direct alternate to the U.S.-operated Global Positioning System (GPS).

### **Global Positioning System (GPS)**

GPS is a satellite navigation system that provides location and time information to a satellite receiver. Since first becoming operational in 1994, GPS has become widely used by civil, commercial and military organizations.

### **Hardened Aircraft Shelter (HAS)**

Also known as Protective Aircraft Shelters (PAS), HAS are reinforced structures that house and protect military aircraft from enemy attack. Cost considerations and building practicalities generally limit their use to fighter size aircraft.

### **Harpoon Missile System**

The Harpoon missile system is an all-weather, over-the-horizon, anti-ship missile system that uses active radar homing and low-level, sea-skimming trajectory to improve survivability and effectiveness. The air-launched variant of the Harpoon is called AGM-84, the ship-launched version is RGM-84, while the submarine-launched variant is called UGM-84. AGM-84L is the designation for the GPS-equipped Harpoon Block II missiles for export. Taiwan is purchasing UGM-84L Block II variants. ATM-84L (air-launched) and RTM-84L (sea-launched) are training variants of the missile system.

### **Have Glass**

The name for two efforts to reduce the radar cross-section of F-16s. Have Glass I adds an indium-tin-oxide layer to the gold tinted cockpit canopy, which dissipates radar signals and reduces its visibility to radar. Have Glass II includes the *Pacer Mud* radar signature reduction and the *Pacer Gem* infrared signature reduction, utilizing paint coatings with ferromagnetic and fiberglass components.

### **HAWK Missile System**

The HAWK surface to air missile system provides medium-range, low to medium altitude air defense against a variety of targets, including jet and rotary wing aircraft, unmanned aerial vehicles, and cruise missiles.

### **HF “Hsiung Feng” “Brave Wind” Missile System**

Developed by CSIST, HF-1 is a short/medium range, beam riding anti-ship missile. HF-2 is a medium/long-range anti-ship missile system with Electronic Counter-Counter Measures (ECCM) capability. It is designed to be deployed from ships or at land-based facilities. A land attack cruise missile variant currently in development is known as the HF-2E.

### **HF-2E (LAM-99) “Hsiung Feng IIE” “Chichun” “Lance Hawk”**

The indigenously developed HF-2E missile is a land-attack cruise missile (LACM) variant of the HF-2 anti-ship missile. Beginning stages of production in 2005, but considered by the MND as still in development, its range performance approaches 1,000 km, which is made possible by an improved turbofan engine. Code names for this program have included “Quick Falcon” and “Chichun” (Lance Hawk). The missile has been tentatively designated the “LAM-99.”

**HF-3 “Hsiung Feng III” “Chuifeng” “Chasing Wind”**

A supersonic anti-ship missile system developed by CSIST, the HF-3 has a range of 300km and can be fitted with a variety of guidance systems. Plans are for deployment on frigates and mobile land-based launchers on the west coast, and it is likely designed to target Chinese surface vessels like the Sovremenny class destroyers. A code name for this program is “Chuifeng” (Chasing Wind).

**HQ-9**

The HQ-9 is a Chinese medium to long-range, active radar homing Surface-to-Air Missile (SAM). Initially an indigenous design, the HQ-9 is believed to have undergone a redesign to incorporate Russian rocket technology after the acquisition of S-300 5V55-series missiles from Russia. There are unconfirmed rumors that the HQ-9 uses a sophisticated guidance system not dissimilar from that used in the U.S. Patriot missile system.

**Hsinchu Air Force Base (AFB)**

An airbase located along Taiwan’s western coast near the city of Hsinchu.

**Hualien Air Force Base (AFB)**

An airbase located along Taiwan’s eastern coast near the city of Hualien. The station is an airport for civil and military uses, with 11.5 hectares of land borrowed from the air force for commercial use.

**Identification Friend or Foe (IFF)**

IFF codes are the primary method towards positive identification of another aircraft. Proper use of such codes facilitates rapid engagement of enemy aircraft, conserves air defense assets, and reduces risk to friendly aircraft.

**Inertial Navigation System (INS)**

Consisting of the Inertial Navigation Unit (INU), a Fire Control Navigation Panel (FCNP), and a battery plus mount, the INS is a prime sensor for aircraft velocity, attitude, and heading, and a prime source of navigation information through its inertial sensors. The FCNP acts as the cockpit input/output device, and provides the interface between the pilot and the INS, while also controlling the Fire Control Computer (FCC).

**Information Warfare (IW)**

Information warfare is the use and management of information in pursuit of a competitive advantage over an opponent. Information warfare may involve collection of tactical information, assurance that one’s own information is valid, spreading of propaganda or disinformation to demoralize the enemy and the public, undermining the quality of opposing force information and denial of information-collection opportunities to opposing forces. Information warfare is closely linked to psychological warfare.

**Inhofe, James**

Inhofe, a Republican, is the senior Senator from Oklahoma. Inhofe served eight years as the U.S. Representative for Oklahoma’s 1<sup>st</sup> congressional district before his election to the Senate in 1994, and also previously served as both an Oklahoma State Representative and State Senator. Inhofe is a co-chair of the Senate Taiwan Caucus.

**Intelligence, Surveillance, and Reconnaissance (ISR)**

ISR encompasses multiple activities related to the planning and operation of systems that collect, process, and disseminate data in support of current and future military operations.

**J-10**

This 4<sup>th</sup> generation aircraft is a new addition to China's People's Liberation Army Air Force. Improvements from older models include a short-take-off ability and improved maneuvering capabilities.

**J-20**

The Chengdu J-20 is a stealth 5th generation twin-engine fighter aircraft prototype developed by Chengdu Aircraft Industry Group for the People's Liberation Army Air Force. The J-20 made its first flight on January 11, 2011.

**Jiashan**

A hidden air base adjacent and to the west of Hualien Air Force Base, utilizing a hollowed out mountain for underground protection of aircraft.

**JDAM (Joint Direct Attack Munition)**

A guidance kit that converts existing unguided free-fall bombs into accurately guided "smart" weapons. The JDAM kit consists of a new tail section that contains an Inertial Navigation System/Global Positioning System. GBU-31(V)1 is intended to be used with the Mk-84 unguided bomb (the laser-guided version is called GBU-56), while the GBU-38 is intended for use with the Mk-82 (the laser-guided version is called GBU-54).

**Joint Helmet-Mounted Cueing System (JHMCS)**

A helmet display system that gives pilots the ability to rapidly acquire and designate a target simply by looking at it. JHMCS also displays aircraft altitude, airspeed, gravitational pull, angle of attack and tactical information on the visor to increase situational awareness. If combined with the AIM-9X, JHMCS allows effective target designation up to 80 degrees either side of the aircraft's nose.

**Joint Mission Planning System (JMPS)**

A new computer system replacing the legacy mission planning computer system, Tactical Automated Mission Planning System (TAMPS).

**Jointness**

The term 'jointness' refers to a synergistic movement by two services (or militaries) toward the completion of a task. The American Dictionary of Military Terms describes it as "employment of forces of two or more services in coordinated action toward a common objective."

**Joint Tactical Information Distribution System (JTIDS)**

A high capacity, high-speed communications system that provides secure, jam-resistant transfer of digital voice or data information, position determination, and unit identification for the U.S. and its allies, principally in the realm of air and missile defense.

**Kadena Air Base**

A U.S. Air Force base located in the towns of Kadena, Chatan, and Okinawa, Japan. Kadena is the hub of U.S. airpower in the Asia Pacific, and is home to the Air Force's 18<sup>th</sup> Wing, along with a variety of associated units.

**Ku-Band Transponder**

The Ku band is a portion of the electromagnetic spectrum in the microwave range of frequencies that is primarily used for satellite communications. A transponder is the mechanism that that receives, amplifies, and retransmits a signal.

**Laser-Guided Bomb (LGB)**

An LGB uses semi-active laser homing to strike a designated target with greater accuracy than an unguided bomb.

**Land Attack Cruise Missile (LACM)**

One of the two primary types of cruise missiles (the other being Anti-Ship Cruise Missiles, or ASCM), an LACM is an unmanned, armed aircraft designed to attack a fixed or mobile ground-based target. It spends the majority of its mission in level flight, as it flies a preprogrammed path to a predetermined target. Propulsion is usually provided by a small jet engine.

**LAU-129**

A Common Rail Launcher (CRL) for the AIM-9 and AIM-120 air-to-air missiles.

**Laser Guided Bomb (LGB)**

A laser-guided bomb (LGB) is a guided bomb that uses semi-active laser homing to strike a designated target with greater accuracy than an unguided bomb.

**Lead-In Fighter Trainer (LIFT)**

An aircraft used to develop war-fighting skills and providing on the job training to military pilots.

**Legislative Yuan (LY)**

The legislative body of Taiwan, the LY currently has 113 members, revised from 225 legislators in January 2008. The LY members are elected in several different ways: 73 are elected under a first-past-the-post system in single-member constituencies, 34 are elected under the supplementary member system on a second ballot, based on nationwide party votes, while 6 seats are elected by aboriginal voters through single non-transferable vote in two 3-member constituencies. Members serve four-year terms.

**Letter of Offer & Acceptance (LOA)**

Standard Department of Defense form on which the U.S. government documents its offer to transfer U.S. defense articles and services to a foreign government or international organization via foreign military sales, pursuant to the Arms Export Control Act.

**Letter of Request (LOR)**

The document that starts the Foreign Military Sales (FMS) government-to-government sales process. The LOR can be a formal letter, E-mail or message requesting articles, military construction, or other services, as well as Price & Availability data. In the U.S., each LOR is reviewed and validated by the Military Department affected, by the DSCA, and by the U.S. Department of State. The Letter of Request carries no obligation to purchase the article or service.

**Lin, Yu-fang**

Lin is a former PFP – now KMT – legislator. He is a co-convenor of the LY's Foreign Affairs & National Defense Committee (FANDC), and is a past Director of the Graduate Institute of International Affairs & Strategic Studies at Tamkang University. He is an outspoken critic of the price of arms procurement packages from the U.S., and a strong advocate of having Taiwan manufacture its own weapons for its armed forces.

**Link-16 (TADIL J)**

Link-16 is a tactical data link employed by the United States Navy, the Joint Services, Japan, and some nations of the North Atlantic Treaty Organization (NATO). Link-16 has certain technical and operational improvements over older tactical data link (Link-11/Link-4A) capabilities, with some data exchange elements. It provides significant improvements, including improved security, increased data rate (throughput), increased amounts/granularity of information exchange, and reduced data terminal size (allowing installation in fighter and attack aircraft). It also offers digitized, jam-resistant, and secure voice capability; relative navigation; precise participant location and identification; and an increased number of participants.

**Lippert, Mark**

Mark Lippert is the current Assistant Secretary for Asian & Pacific Security Affairs in the U.S. Department of Defense. He formerly served as the chief-of-staff for the National Security Council. His nomination to this position was initially held up by Texas Sen. John Cornyn (R-Texas) over the Obama Administration's failure to address Taiwan's aging fleet of fighter jets.

**Lockheed Martin**

Headquartered in Bethesda, Maryland, Lockheed Martin is a multinational aerospace and defense manufacturer and advanced technology company that employs about 146,000 people worldwide. The majority of Lockheed Martin's business is with the U.S. Department of Defense and U.S. federal government agencies, but the company also does business with international governments, and has some commercial sales of its products, services and platforms.

**Low Observable**

Low observable technology cover a range of techniques used with personnel, aircraft, ships, submarines, and missiles, to make them less visible (ideally invisible) to radar, infrared, sonar and other detection methods.

**Luke Air Force Base (AFB)**

Based in Maricopa, Arizona, Luke AFB is a major training base of the Air Education and Training Command, training pilots – including Taiwan fighter pilots – in the F-16 Fighting Falcon. The 56th Fighter Wing is the host unit at Luke. The 56th Operations Group has operational control and responsibility for the entire fighter-training mission at Luke.

**M-346 Master**

A military transonic trainer aircraft manufactured by Italian company Alenia Aermacchi, based on a previous design by an Italy/Russia joint venture. The M-346 is designed for training combat pilots for front line fighter aircraft. The first prototype rolled out in June 2003, with the maiden flight on July 15, 2004. Alenia Aermacchi has announced orders for the M-346 from the Air Forces in Italy and Singapore.

**Ma, Ying-jeou**

President of Taiwan since 2008, reelected in 2012, and the current Chairman of the Kuomintang (KMT), Ma is widely seen as representing a new generation within his party. Ma also served as Chairman of the KMT between 2005 and 2007, and is the former mayor of Taipei (1998-2006). Previous government service includes as Minister of Justice, as Deputy Minister of the Mainland Affairs Council, and in the Office of the President under late President Chiang Ching-kuo. He holds degrees from Harvard Law School, New York University and National Taiwan University.

**Mean-Time Between Failure (MTBF)**

The predicted elapsed time between inherent failures of a system during operation.

**Menendez, Robert**

A Democrat serving as the junior senator from New Jersey. Prior to joining the U.S. Senate, he was a member of the House of Representatives, representing New Jersey's 13th congressional district. He previously served as Mayor of Union City (1986–1992) and as a member of the New Jersey General Assembly and the New Jersey Senate. Menendez is a co-chair of the Senate Taiwan Caucus.

**MICA Missile**

The MBDA MICA (Missile d'Interception et de Combat Aérien, or "Interception and Aerial Combat Missile") is an anti-air multi-target, all weather, fire-and-forget short and medium-range missile system. It is intended for use by air platforms as well as by ground units and ships, which can be equipped with the rapid fire MICA Vertical Launch System. The first trials occurred in 1991, and the missile was commissioned in 1996 to equip the Rafale and Mirage 2000 aircraft. It is a replacement for both Super 530 (interception) and Magic II (dogfight).

**Mid-Life Update/Upgrade (MLU)**

The term refers to the process of upgrading a system to enhance survivability and to extend its service life. Updates can include additional hardware and/or software upgrades, retrofitting of new technology, updating communications and navigation systems, or other modifications to keep pace with high tech advances in sensors, weaponry, and communications.

**MIDS-LVT/MIDS On-Ship (MOS)**

The Multifunctional Information Distribution System-Low Volume Terminal (MIDS-LVT) is an advanced Link-16 command, control, communications, and intelligence system incorporating high-capacity, jam-resistant, digital communication links for exchange of near real-time tactical information – including both data and voice, among air, ground, and sea elements. MIDS-LVT is intended to support key theater functions such as surveillance, identification, air control, weapons engagement coordination, and direction. The MIDS ON-Ship (MOS) variant supports key theater functions from naval platforms.

**Ministry of National Defense (MND)**

The MND is responsible for formulating military strategy, setting military personnel policies, formulating draft and mobilization plans, delineating supply distribution policies, arranging the research on and development of military technology, compiling the national defense budget, setting military regulations, conducting court martial proceedings, and administering military law. Within the Ministry of National Defense is the General Staff Headquarters (GSH), under which are the various services, including the Army, Navy, Air Force, Combined Services Forces, Armed Forces Reserve Command/Coast Guard Command, Military Police Command. The MND also has other subordinate agencies such as military academies, military courts, prosecutorial bureaus, and jails, as well as R&D institutions like CSIST.

**Mirage 2000-5 [Ei/Di]**

The Mirage 2000-5 by Dassault Aviation is a multi-role fighter, its multiple-target air-to-ground and air-to-air firing procedures linked to the use of RDY radar and a visualization and control system. As a combat aircraft

with versatile air-to-air mission capabilities, the Mirage 2000-5 is designed for the most-advanced armaments. Taiwan currently fields both the Ei & Di variants.

**Missile Warning Center (MWC)**

An MWC manages a set of ballistic missile sensors and its reporting systems to provide timely, accurate, and unambiguous warnings of a missile attack.

**Modular Mission Computer (MMC)**

A type of aircraft mission computer for the F-16 fighter, the MMC provides airborne processing power and delivers enhanced computing power to the aircraft's avionics and weapon systems. For pilots, the MMC can significantly improve situational awareness, air-to-air capabilities, targeting accuracies, and information. MMC is used as a cost-effective mid-life update for the F-16.

**Mullen, Michael**

Admiral Michael Glenn “Mike” Mullen was the Chairman of the Joint Chiefs of Staff, serving as the principal military advisor to the President, Secretary of Defense, the National Security Council, and the Homeland Security Council. His previous assignments include Chief of Naval Operations and Commander of US Naval Forces Europe. Admiral Mullen graduated from the US Naval Academy in 1968. He is also a graduate of the Advanced Management Program at Harvard Business School and earned a Master of Science degree in Operations Research from the Naval Postgraduate School.

**Nanjing Military Region**

One of seven military command regions for the Chinese People’s Liberation Army. Its jurisdiction covers all military and armed police located in Anhui, Jiangsu, Zhejiang, Jiangxi, Fujian, and Shanghai. The International Institute for Strategic Studies lists the formation with an estimated 250,000 personnel, three group armies, two armored, one mechanized infantry, three motorized infantry, and one artillery division. There are also one armored, four motorized infantry, two artillery, three anti-aircraft brigades, plus an anti-tank regiment. The headquarters for the East Sea Fleet are located within the region, at Ningbo.

**National Security Council (NSC)**

The National Security Council’s function, in both the U.S. and Taiwan, is to advise the President on matters of national security and foreign affairs. In the United States, the NSC is part of the Executive Office of the President, and includes the Vice President, Director of National Intelligence, and the Secretaries of State, Treasury, and Defense, among others. In 1967, the Taiwanese National Defense Council was renamed the National Security Council, but maintained its oversight role of the National Security Bureau (Taiwan’s national intelligence agency). The NSC is still presided over by the Taiwan President.

**Non-Recurring Engineering (NRE)**

Refers to the one-time cost incurred during new product development, such as cost of labor and product testing, etc. Such expenditures are usually offset later by the profits made from mass production.

**Nuclear, Biological, and Chemical Defense (NBCD)**

A form of defensive warfare focusing on the combination of nuclear, biological, and chemical threats to humans and their environment.

**Obama, Barack**

Barack Obama is the current President of the United States. Elected in 2008, Mr. Obama previously served in the U.S. Senate as a representative from Illinois, as a member of the Illinois Senate, and prior to which he worked as a community organizer and civil rights attorney in Chicago. He holds degrees from Columbia University and Harvard. In April 2011, Mr. Obama announced his intention to seek reelection in the 2012 presidential election.

**Offensive Counter Air**

Offensive Counter-Air (OCA) is a military term for the suppression of an enemy's military air power by destroying or disabling the aircraft—preferably on the ground.

**Operation Iraqi Freedom**

Operation Iraqi Freedom was the armed invasion of Iraq by coalition forces that began on March 20, 2003, with the goal of removing Saddam Hussein and his government.

**Operational Conversion Unit (OCU)**

A unit within an air force whose role is to support preparation for the operational missions of a specific aircraft type by providing trained personnel. OCUs teach pilots how to fly an aircraft and which tactics best exploit the performance of their aircraft and its weapons.

**Operational Flight Program (OFP)**

An Operational Flight Program (OFP) is the embedded software that performs the functions and sub-functions necessary for aircraft weapon systems to operate.

**Operations & Maintenance**

O&M refers to the broad spectrum of services required to assure that a piece of equipment will continue to perform. It typically includes the day-to-day activities necessary for the asset and its systems and equipment to perform the function for which it was designed and constructed.

**Osan Air Base**

Osan Air Base (K-55), is a United States Air Force facility located in the Songtan section of Pyeongtaek City, South Korea, 64 km (40 mi) south of Seoul.

**PAC-3 “Patriot” (Patriot Advanced Capability 3)**

The Patriot Advanced Capability 3 is an advanced surface-to-air guided missile defense system effective against low-to-high-altitude air threats in defense of ground combat forces and critical assets. Its key features are the multifunction phased array radar, missiles with semi-active and active guidance, and automated operations with capabilities for human override. The PAC-3 missile is a highly agile hit-to-kill interceptor for defense against tactical ballistic missiles, cruise missiles, and air-breathing threats, and destroys its targets by direct, body-to-body impact.

The PAC-3/Configuration 3 is an improved PAC-2+ system, introducing an upgraded AN/MPQ-65 radar to increase detection in high-clutter environments, and to improve discrimination of closely spaced objects (better decoy recognition).

**“Paveway” Laser-Guided Precision Munition Kit**

The Paveway kit transforms "dumb" bombs into precision laser-guided weapons. The kit contains a nose-mounted laser seeker and guidance fins, and requires external input in the form of laser designation of the intended target. While Paveway I has fixed wings, Paveway II has folding wings and other improvements including reduced weight and cost, increased detector sensitivity and field of view, etc. The Paveway III system has a wider field of view and proportional guidance, minimizing the energy loss of course corrections. Paveway III also has a considerably longer glide range and greater accuracy than Paveway II.

GBU-10 Paveway II/GBU-24 Paveway III is intended for use with the Mk-84 unguided bomb, GBU-12 Paveway II for the Mk-82.

**People’s Liberation Army (PLA)**

The PLA serves as the military of the People’s Republic of China (PRC) and is comprised of Ground Forces, Navy (PLAN), Air Force (PLAAF), two Artillery Corps (strategist missile forces) and the Peoples Armed Police Force. Estimated at 2.3 million personnel, the PLA is the largest standing military in the world. The PLA was established in 1927 as the military arm of the Communist Party of China and was originally designated the “Red Army.” The semi-autonomous organization reports to two Central Military Commissions, one belonging to the state and one belonging to the party.

**Peoples Republic of China (PRC)**

The official name of the Mainland China-based government.

**Phased Array Radar**

Phased array systems provide a number of features which make them particularly suitable for long range, high target density, radar applications such as satellite tracking and space surveillance. These include long-range detection capability, high transmitted power, inertia-less electronic beam steering, multiple receiving-beam capability, high reliability and extreme flexibility.

**PL-12**

This active-guided air-to-air missile benefits from Russian technology and has an estimated 70 to 100km range, making it competitive with the Russian R-77 and the U.S. AMRAAM.

**Po Sheng “Broad Victory” Project**

The C4ISR project codenamed “Po Sheng” is aimed at integrating different weapons systems of the three services in Taiwan by building data links (see Link-16) between them. The goal is to share information in real time. The main Po Sheng project for the Taiwan military was completed in 2009. The next phase is called the Shyun An “Quick & Secure” project.

**PRC Missile Tests (Third Taiwan Strait Crisis)**

The 1995-1996 Taiwan Strait Crisis was the effect of a series of missile tests conducted by the People’s Republic of China in the waters surrounding Taiwan, including the Taiwan Strait, from July 21, 1995 to March 23, 1996. The first set of missiles fired in mid to late 1995 were intended to send a strong signal to the Republic of China government under Lee Teng-hui, who had been seen as moving ROC foreign policy away from One-China. The second set of missiles, fired in early 1996, was intended to intimidate the Taiwanese electorate in the run-up to the 1996 presidential election.

**Precision-Guided Munition (PGM)**

This term refers to weapons used in precision bombing missions. They are usually specially designed guided munitions, or normal bombs fitted with kits to allow them to be guided to their target.

**Price & Availability Data (P&A)**

P&A is the estimated cost and delivery data for one or all the items associated with a project, gathered to prepare a feasibility study. In military terms, it is one of the first steps in an FMS case. A foreign government will request P&A data on the U.S.-produced items it is interested in purchasing.

**Probability of Kill (Pk)**

The probability that engagement between a weapon and a target will result in a kill.

**R.550 Magic II**

The Magic II is a short range, air-to-air missile designed for close-in engagements. The missile features an IR seeker, and is the French counterpart to the U.S. Sidewinder missile. It is used on Mirage fighter jets, among other platforms.

**Radar Cross-Section (RSC)**

RSC is the measure of how detectable an object is with radar. A number of factors may contribute to the size of a radar cross-section, including the material of the object, absolute and relative size, and angle from the radar source. Reducing RSC is instrumental in stealth technology.

**Radar Warning Receiver (RWR)**

RWRs are systems that detect the radio emissions of radars, with the primary purpose of issuing a warning when a radar signal that might be a threat is detected. The warning can then be used, manually or automatically, to evade the detected threat. RWR systems can be installed in airborne, sea-based, and ground-based assets.

**RAND Corporation**

[www.rand.org](http://www.rand.org)

The RAND Corporation (Research ANd Development) is a nonprofit global policy think-tank initially formed to offer research and analysis to the United States armed forces. It is financed by the U.S. government and from a private endowment, as well as by contributions from corporations, universities and private individuals. RAND aims for interdisciplinary and quantitative problem solving via translating theoretical concepts from formal economics and the hard sciences into novel applications in other areas.

**Rapid Runway Repair (RRR)**

RRR is an integral part of BRAAT (Base Recovery After Attack) operations. A type of large-scale, horizontal construction engineering operation, RRR is conducted on short notice but without the aid of construction drawings or standardized plans. After an enemy attack, damaged runways must be quickly repaired to support aircraft launch and recovery operations. Actual repairs and damage estimates will be based on the threat munitions used during the attack and categories of damage.

**Ready 5/6/15, etc.**

A Ready or Alert number indicates the condition of readiness of an aircraft. Ready 5 is a condition of high alert, where the aircraft is capable of launching on five minutes' notice – generally meaning that the pilot is strapped

in the seat and the plane has been preflighted, fueled, and armed. Other Ready numbers (15/30, etc.) indicate the number of minutes required to launch the aircraft.

### **S-300 PMU-2**

A Russian long-range surface-to-air missile system, developed to defend against aircraft and cruise missiles for the Soviet Air Defense Forces. Subsequent variations were developed to intercept ballistic missiles, and in 1997, the S-300PMU-2 was introduced as an upgrade. This system is reportedly capable not just against short-range ballistic missiles but also against medium-range tactical ballistic missiles. China was the first foreign government to purchase the system from Russia.

### **Second Artillery Corps**

The SAC is the component of the PLA that controls China's strategic missile forces. It comprises approximately 100,000 personnel and six ballistic missile brigades, independently deployed in different military regions throughout the country. Established in 1966 and headquartered in Qinghe, Beijing, it is under the direct command of the Central Military Commission.

### **Shirakaba/Chunxiao Gas Field**

The Chunxiao natural gas field, also known as the Shirakaba gas field in Japanese, lies in the East China Sea within the Chinese Exclusive Economic Zone (EEZ) and 4 km to the west of the EEZ border claimed by Japan – which is disputed by China.

### **Shizishan**

Shizishan is a hardened aircraft storage area being built adjacent to the Taitung AFB.

### **Short-Range Ballistic Missile (SRBM)**

A short-range ballistic missile (SRBM) is a ballistic missile with a range of about 1,000 km or less that is usually mobile. Warheads can include conventional high explosive, chemical/biological and nuclear warheads. In potential regional conflicts, these missiles would be used because of the short distances between some countries and their relative low cost and ease of configuration.

### **Short Takeoff and Vertical Landing (STOVL)**

STOVL refers to the ability of some aircraft to take off from a short runway and land vertically (i.e. with no runway). Both the Harrier Jump Jet (although technically a Vertical Take-Off and Landing/VTOL aircraft) and the F-35 Joint Strike Fighter – with demonstrated VTOL capability in test flights – are operationally STOVL.

### **Shyun An “Quick & Secure” Project**

The C4ISR project codenamed “Shyun An” (“Syun An”) is a follow-on project of life-cycle and engineering support and software maintenance for the Po Sheng project, which the Taiwan military completed in 2009. The overarching goal of these projects is to share information in real time between services.

### **Six Assurances**

Promises made to Taiwan by President Ronald Reagan in June 1982. The six assurances were that the U.S. would not set a date for termination of arms sales to Taiwan; would not alter the terms of the Taiwan Relations Act; would not consult with China in advance before making decisions about U.S. arms sales to Taiwan; would not mediate between Taiwan and China; would not alter its position about the sovereignty of Taiwan (which was that the question was one to be decided peacefully by the Chinese themselves, and would not pressure

Taiwan to enter into negotiations with China); and that the U.S. would not formally recognize Chinese sovereignty over Taiwan.

**SNECMA M-53 Engine**

The SNECMA M53 is an afterburning turbofan engine developed for the Dassault Mirage 2000 fighter by the French aerospace firm Snecma.

**SU-27**

The Sukhoi Su-27 is a one-seat Mach-2 class jet fighter with a 3,530 km range, heavy armament, sophisticated avionics and high agility. Originally manufactured by the Soviet Union, China acquired 76 Su-27 fighters from Russia before signing an agreement in 1998 to redesign China's own versions of the plane as the Shenyang J-11.

**SU-30**

The Sukhoi Su-30 is a twin-engine, two-seat, multi-role military aircraft developed by Russia and introduced into operational service in 1996 as a dual-role fighter for all-weather, air-to-air and air-to-surface deep interdiction missions. The PLAAF operates 76 Su-30MKKs and the PLANAF operates 24 Su-30MK2.

**Suppression of Enemy Air Defenses (SEAD)**

The effort undertaken – typically early in an attack – to suppress the enemy's air defense capabilities.

**Surface-to-Air Missile (SAM)**

A radar- or infrared- guided missile, fired from a position on the ground to intercept and destroy enemy aircraft or missiles. SAMs are generally classified by their guidance, mobility, altitude, and range, and vary from man portable versions (MANPADS) to large fixed installations.

**Surface-to-Surface Missile (SSM)**

A surface-to-surface missile (SSM), or ground-to-ground missile (GGM or GTGM), is a missile designed to be launched from the ground or the sea and to strike targets on land or at sea.

**Surveillance Radar Program (SRP)**

SRP is the name for a foreign military sales (FMS) acquisition to provide an integrated early warning radar system for Taiwan. Planned missions for the system include missile warning, air-breathing threats, and maritime ship tracking. This system, consisting of a UHF phased array radar and 2 Missile Warning Centers (MWCs), will be installed and tested at locations in Taiwan and integrated into Taiwan's Military Information Communication System (MICS).

**T-50 "Golden Eagle"**

An indigenous South Korean supersonic trainer aircraft developed by Korea Aerospace Industries (KAI) beginning in the late 1990s based on the F-16 design. The T-50 took its maiden flight in 2002 and entered active service with the Republic of Korea Air Force in 2005. It is used as a trainer aircraft for fifth-generation fighters.

**Tactical Ballistic Missile (TBM)**

A ballistic missile designed for short-range – typically less than 300 km – and for bridging the gap between conventional rocket artillery and longer-range theatre ballistic missiles. TBMs are generally mobile, ensuring

survivability and giving the ability to deploy quickly, and can carry a variety of warheads, including conventional high explosive, chemical/biological, and nuclear.

### **Taipei**

Taipei City, situated at the northern tip of the island, is the capital and largest city in Taiwan, center of Taiwan's culture and economy. It is a direct-controlled municipality under the Executive Yuan, having the status of a province. It is governed separately from the adjacent New Taipei City (formerly Taipei County). The term "Taipei" can also be used to refer to the central government of Taiwan.

### **Taitung Air Force Base (AFB)**

The Taitung Air Force Base (previously known as the Chih-hang AFB) is located on Taiwan's southeastern coast, in the city of Taitung. A major hardened aircraft storage facility, rumored to have a capacity for between 60-80 aircraft, is in the process of being completed here.

### **Taiwan Airpower Modernization Act (TAMA)**

The Taiwan Air Power Modernization Act of 2011 (S.1539 and H.R.2992) is the name for a bill introduced both in the Senate and the House, intended "to provide Taiwan with critically needed United States-built multirole fighter aircraft to strengthen its self-defense capability against the increasing military threat from China." The bill directs the President to carry out the sale of no fewer than 66 F-16C/D multirole fighter aircraft to Taiwan. The legislation, still pending, was sponsored by Senator John Cornyn (R-TX) and Representative Kay Granger (R-TX12).

### **Taiwan Airpower Report**

A report submitted to congress in January 2011 over one year late. It outlined the present state of Taiwan's air power capabilities and made recommendations on how to proceed.

### **Taiwan Relations Act (TRA)**

Following termination of official relations between the U.S. and Taiwan on January 1, 1979, Congress signed into law the Taiwan Relations Act to authorize "the continuation of commercial, cultural, and other relations" between the U.S. and Taiwan. The Act also established the American Institute in Taiwan as the organization through which such relations would be handled, stipulated that the U.S. would "provide Taiwan with arms of a defensive character," and set the legal framework for the current relationship. The TRA is Public Law 96-8, 96th Congress.

### **Taiwan Strait**

The Taiwan Strait is a 180 km-wide section of ocean between Fujian Province on mainland China and the island of Taiwan. The strait is part of the South China Sea and connects to the East China Sea to the northeast. The narrowest part is 131 km wide. Beijing and Taipei respect a "middle line" in the Taiwan Strait, sometimes called the Taiwan Strait Meridian, and have generally kept their warplanes and ships from crossing this line. The "middle line" or Taiwan Strait Meridian was drawn by the United States when it signed the – since obsolete – Mutual Defense Treaty with Taiwan in 1954.

### **TC Tien-Chien "Sky Sword" Missile System**

TC-1 is a short-range IR guided air combat missile, with ECCM (electronic counter-countermeasures) and "fire and forget" capability. TC-2 is an air-to-air medium-range intercept missile, with mid-course inertial guidance

and terminal homing guidance. TC-2 has the capabilities of multiple target engagement and ECCM. The TC-2A is an indigenously developed anti-radiation variant of the Sky Sword missile.

**TC-2A “Sky Sword” Anti-Radiation Missile**

The TC-2A air-to-surface Anti-Radiation Missile (ARM) is being developed by CSIST. The missile uses both active and passive radar guidance and has a range of between 74km and 90km, enabling its carrier plane to fire at targets along China's southeastern coast from a safe distance in the Taiwan Strait. The missile is expected to considerably enhance Taiwan's retaliatory strike capability.

**Thales S.A.**

Thomson-CSF was re-named Thales in December 2000, following the company's acquisition of Racal Electronics plc, a UK defense electronics group. Thales is a leading international electronics and systems group, serving defence, aerospace, security and services markets worldwide. The Group has operations in more than 30 countries, employs over 60,000 people throughout the world, and generated revenues of 10.3 billion euros in 2005.

**TK-3 “Sky Bow” Anti-Tactical Ballistic Missile**

The TK-3 is an indigenous Anti-Tactical Ballistic Missile (ATBM)-capable surface-to-air missile system, upgraded with a longer range and improved anti-missile capability over its predecessor TK-2. Under research and development at CSIST for a number of years, the TK-3 system began operational testing and evaluation in 2006.

**Tomahawk Missile System**

The Tomahawk missiles are a family of all-weather, jet engine-powered, subsonic cruise missiles for attacking a variety of surface targets. A modular design allows for a wide variety of warhead, guidance and range capabilities. The RGM-109 is a ship-launched, radar-guided land-attack cruise missile with a turbofan engine.

**Transporter-Erector-Launcher (TEL)**

The term for a vehicle that can carry, elevate to firing position, and launch one or more missiles.

**Turbofan Engine**

The most common version of a turbojet engine that is used in most military and civilian aircraft, as well as in jet-powered munitions.

**UHF Radar**

UHF is a radar system that takes advantage of the qualities of “Ultra High Frequency” radio waves. The system runs between 300-1000MHz and is capable of operating at very long ranges. The system is especially well suited for ballistic early warning.

**Unmanned Aerial Vehicle (UAV)**

UAV refers to aircraft that navigate by remote control or by internal guidance systems. Originally designed for reconnaissance and intelligence-gathering, UAVs have come into the public eye through their recent use in combat and search & destroy missions. The Predator UAV is perhaps the most famous incarnation of this type of aircraft.

**U.S. Department of Defense (DoD)**

DoD is the federal department that coordinates and supervises all agencies and functions relating directly to national security and the armed forces (Army, Navy, Air Force, Marine Corps). It is the parent agency for the U.S. military, as well as for several U.S. intelligence agencies. The department is headed by the U.S. Secretary of Defense.

**U.S. Department of State (State)**

The State Department was created in 1789, making it the first Executive department established in the United States. It is the lead foreign affairs agency responsible for the international relations of the U.S. The department is headed by the U.S. Secretary of State.

**U.S. House of Representatives**

The United States House of Representatives is one of the two houses of the Congress of the United States, the other being the U.S. Senate. It is conventional to consider the House as the "lower house", and the Senate as the "upper house", although the U.S. Constitution, while making the functions of the two houses different in various ways, does not use such language. Each state is represented in the House in accordance with the size of its population, with the proviso that each state is entitled to at least one Representative member. The total number of Representatives is fixed by law at 435, who each serve two-year terms. The presiding officer of the House is known as the Speaker.

**U.S. Senate**

The United States Senate is one of the two houses of the Congress of the United States, the other being the U.S. House of Representatives. It is conventional to consider the Senate as the "upper house" and the House as the "lower house", although the U.S. Constitution, while making the functions of the two houses different in various ways, does not use such language. Each state is represented by two Senators, regardless of population. The 100 Senators serve staggered six-year terms. The Vice President is the President of the Senate, with authority to preside over sessions, but can only vote to break a tie. The Majority and Minority Leaders represent their parties' interests on the Senate floor.

**Vertical and/or Short Take-off and Landing (VSTOL)**

A term used to describe aircraft that are able to take off and/or land vertically on very short runways. Developed to allow jets to be operated from forest clearings, short runways, and highways close to the enemy, and from small aircraft carriers that would previously only have been able to carry helicopters.

**Wang, Jin-Pyng**

Wang is President of Taiwan's Legislative Yuan. Wang is widely seen as a soft-spoken and conciliatory figure that, while a very shrewd politician, is also clean and not corrupt. Wang has served as an LY member for the Kuomintang (KMT) since 1976.

**Wind-Corrected Munition Dispenser (WCMD)**

WDMD is a tail kit for use with the Tactical Munitions Dispenser family of cluster bombs to convert them to precision-guided weapons. The kit steers munitions from a known release point to precise target coordinates while compensating for launch transients, winds aloft, surface winds, and adverse weather.

**Within Visual Range (WVR)**

A term generally used to describe Air-to-Air Missiles (AAM) designed to engage opposing aircraft at ranges of less than approximately 20 miles (32 km). These short-range missiles emphasize agility, and most use infrared guidance and are called heat-seeking missiles. See also BVR (Beyond Visible Range).

**Y-8 (Shaanxi)**

The Shaanxi Y-8 or Yunshuji-8 aircraft is a medium size medium range transport aircraft produced by Shaanxi Aircraft Company in China, based on the Soviet Antonov An-12.

**Yellow Sea**

The Yellow Sea is the name given to the northern part of the East China Sea, which is a marginal sea of the Pacific Ocean.



***The Looming Taiwan Fighter Gap***

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