



Taiwan's Indigenous Defense Industry: Centralized Control of Abundant Suppliers



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Cover: On March 21, 2017, Taiwan President Tsai Ing-wen signs the Memorandum of Understanding to develop Indigenous Defense Submarines.¹

¹ Taiwan President Tsai signs MOU to develop indigenous submarines," photo for public use through creative commons, <https://commons.wikimedia.org/wiki/>

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Executive Summary

With some foreign assistance, Taiwan has successfully developed its own fighter aircraft, missile systems, surface ships, radars, rocket artillery, armored vehicles, and assault rifles. Taiwan's success is unsurprising since it is an advanced economy with a highly educated populace and already has manufactured cutting-edge computer technology for decades. Taiwan's indigenous defense industry totals over \$2.3 billion US dollars per year in revenue, which is over 23 percent of its annual defense budget. Almost all of those dollars go to major government-affiliated organizations such as National Chung-Shan Institute of Science and Technology (NCSIST), Aerospace Industrial Development Corporation (AIDC), Taiwan International Shipbuilding Corporation (CSBC, formerly China Ship Building Corporation) rather than small and medium sized enterprises (SME). SMEs only account for \$33 million US dollars share of the market, which is less than half a percent. We assess that Taiwan is capable of fulfilling half of its future defense equipment requirements on its own, but must rely on international cooperation for the other half—vertical lift fighter aircraft, utility helicopters, indigenous submarines—that are highly sophisticated.

The size, strength, and technical sophistication of Taiwan's own domestic defense industry has arisen in large part because the government's requests for advanced weapons platforms from the United States and other countries have frequently faced significant decision-making delays as requests become grouped together for a decision once in one or two years, or complete long-term lack of action tantamount to rejection from the United States and others. The Tsai Ing-wen administration has committed to increasing defense budgets and developing a variety of new, indigenously produced advanced weapons platforms, including an ambitious plan to create Taiwan's first indigenous submarine fleet.

To the extent that the international audience is aware of Taiwan's defense procurement, the impression at face value is that Taiwan is primarily a purchaser of American military equipment. It is true that Taiwan

relies on the United States to provide some of its most advanced weapons systems, including the F-16 fighter aircraft, UH-60M Black Hawk helicopters, Patriot PAC-III interceptor missiles and entire missile defense systems. As of this report's writing, Taiwan's Ministry of National Defense was also reportedly interested in F-35 Joint Strike Fighters. The United States approved "marketing" licenses for components for Taiwan's indigenous submarine program, but have yet to approve "export" licenses for those components.

Despite being such an important feature of one of East Asia's most critical security hotspots, Taiwan's defense industry is perennially understudied in English-language sources. While there is much writing on individual weapons platforms, events, and cross-strait contingency planning, there is no recent study examining Taiwan's indigenous defense industry as a whole. This report therefore seeks, first and foremost to provide an up-to-date overview of Taiwan's indigenous defense industry: its structure, its participants, its major platforms and future directions, and degree of foreign assistance is necessary for it to achieve its goals. We have also sought to conclude the report with recommendations for how Taiwan can fulfill the Tsai Administration's plan for a strengthened indigenous defensive deterrent, and how the United States and other partners can help. For this study, Global Taiwan Institute's (GTI) researchers interviewed Taiwan's former National Security Council officials, Taiwan's current naval officers, and current and former US government officials who work on Taiwan arms sales, in addition to extensive reviews of academic writings, think tank reports, trade writings, and news articles on Taiwan's defense industry.

It is the authors' hope that our findings are illuminating for policymakers in Taiwan, the United States, and elsewhere seeking to better understand Taiwan's capabilities not as a passive recipient of defense assistance, but as an active participant in shaping its future security, and as home to one of the Asia-Pacific region's most capable defense manufacturing bases.

Introduction

Taiwan has long maintained a robust indigenous defense manufacturing base, capable of producing weapons and equipment for all three major military services. As the People's Republic of China (PRC) modernizes and strengthens its military, introducing capable new weapons platforms at an impressive pace, Taiwan has been obligated to develop and acquire the military technology necessary to deter its cross-Strait rival.²

In examining how Taiwan's indigenous defense industry plans to rise to the challenge, this report opens by asking what weapons Taiwan requires, and which it can make itself, using the two dozen advanced military platforms mentioned in Taiwan's 2017 Quadrennial Defense Review (QDR) and latest National Defense Report (NDR) as a reference baseline.³ After all, Taiwan's 2017 National Defense Report explicitly directs: "Absolutely no overseas purchase when domestic manufacturers can supply; when capability is lacking, provide guidance to upgrade technology level."⁴ Indeed, Taiwan's entire indigenous defense industry is worth over \$2.3 billion US dollars per year, which is over 23 percent of its annual defense budget.⁵ The vast majority to made up by major government-affiliated defense organizations National Chung-Shan Institute of Science and Technology (NCSIST), Aerospace Industrial Development Corporation (AIDC), Taiwan International Shipbuilding Corporation (CSBC, formerly China Ship Building Corporation) rather than small and medium sized enterprises (SME).

The report's second section looks at the SMEs that work together with larger government-affiliated firms. These 200 small and medium-sized defense industry suppliers manufacture optical components, wires, sensors, communications devices, high quality steel, and other items. These SMEs form the foundation of Taiwan's defense industry because they supply the raw materials and basic components that are integrated into Taiwan's indigenous weapons systems. We closely examined 88 of those manufacturers to understand

their product offerings and geographic location, and created a heat map that confirms the clustering of aerospace suppliers proximate to the AIDC, naval suppliers near CSBC, and firms supplying all service branches near NCSIST. The heat map also reflects the degree of centralized government supervision within the industry. Smaller suppliers in the highly centralized aerospace are tightly clustered around AIDC, but there is only moderate clustering tied to CSBC in the ship-building industry, and a relatively decentralized group of companies that supply army equipment.

In the third section, this report examines the structure, current capabilities, and future directions of Taiwan's domestic defense base, broken down by service, with a focus on the most notable past military programs such as Indigenous Defense Fighter (IDF) aircraft, Hsiung Feng Missiles, fast missile boats, and future programs such as Indigenous Defense Submarine (IDS). The IDS is given special attention, as it represents Taiwan's most ambitious indigenous defense effort since the push to build the IDF more than twenty-five years ago. From this section on, our conclusion begins to emerge regarding the highly centralized nature of Taiwan's defense industry, structured around the state-affiliated giants NCSIST, AIDC, and CSBC.

We end the report with policy recommendations, centered on the bottom-up creative technological benefits that Taiwan's military would gain in unlocking its small and medium-sized defense companies by expanding security clearances to include private sector employees, and broadening the information security network so these companies can be more directly involved in planning and producing Taiwan's defensive capabilities.

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2 U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2016* (Washington, D.C., 2016), www.defense.gov

3 Ministry of National Defense (Taiwan), *Quadrennial Defense Review 2017* (Taipei, 2017), <https://www.mnd.gov.tw>

4 Ministry of National Defense (Taiwan), *National Defense Report 2017* (Taipei, 2017), 120. <https://www.mnd.gov.tw>

5 Ministry of National Defense (Taiwan), *National Defense Report 2017*, 135. Calculate an estimate of percentage of money spent on indigenous industries relative to Taiwan's overall defense budget: Taiwan's defense budget is roughly \$300 billion NT per year, which is equivalent to approximately \$10 billion US dollars. Therefore, since the entire indigenous defense industry is worth over \$2.3 billion, it stands at over 23% of the entire defense budget.

Future Military Hardware Requirements

From the analysis in the figures below, it appears that half of the list of Taiwan's future defense requirements would only be possible with international collaboration. Taiwan's defense publications technically list them all as "future" requirements, they should also be considered current requirements to be attained as soon as possible since there is an immediate need for a stronger military. Some of the items are extremely sophisticated technology that would require collaboration with foreign companies to produce or to buy entirely 'commercial off the shelf' (COTS). They include domestically produced diesel-electric submarines; advanced fighters with stealth, vertical lift, long range, and beyond visual range (BVR) combat capabilities; high-speed stealth naval vessels; electronic surveillance; electronic warfare; and electronic countermeasure systems to prevent electronic attack, interference, and paralysis. Taiwan would have trouble manufacturing these items without outside assistance, and would require, at the very least, that foreign companies supply components for installation on an indigenously produced platform.

Future requirements according to Taiwan's National Defense Reports:	Can it be 100% indigenously produced?	Greatly benefit from international collaboration?	Need international collaboration?
Modern diesel-electric submarines			Yes
High performance surface vessels	Yes	Yes	
New utility helicopters			Yes
Shipborne multi-role helicopters			Yes
Advanced fighters with stealth, long range, and beyond visual range (BVR) combat capabilities			Yes
Air-dropped sea mines	Yes	Yes	
Enhanced mine-laying capabilities	Yes	Yes	
Precision strike weapons	Yes	Yes	
Unmanned aerial vehicle systems (UAV)	Yes	Yes	
Electronic surveillance			Yes
Countermeasure systems			Yes

Above figure 1: Taiwan's future military hardware requirements according to Taiwan's 2015 and 2017 National Defense Reports.⁶

Future requirements according to Taiwan's National Defense Reports:	Can it be 100% indigenously produced?	Greatly benefit from international collaboration?	Need international collaboration?
Strengthening information, communications and electronic warfare capabilities, such as offensive and defensive information and electronic warfare			Yes
Vertical or short-takeoff and landing (V/STOL) aircraft with stealth characteristics			Yes
Upgrade main operational naval vessels	Yes	Yes	
Strengthen air-defense missile capabilities	Yes	Yes	
Enhance long-distance strike firepower	Yes	Yes	
Domestically produce submarines			Yes
High speed stealth naval vessels			Yes
Shore-based mobile missiles	Yes	Yes	

Above figure 2: Taiwan's future military hardware requirements according to Taiwan's latest 2017 Quadrennial Defense Review adds these future defense requirements.⁷

However, based on Taiwan's indigenous defense manufacturing capabilities, our report assesses with moderate confidence that Taiwan will be able to single handedly meet half of its future defense requirements. With little or no international assistance, its indigenous defense industries can produce high performance surface vessels, airdropped sea mines, enhanced mine laying capabilities, precision strike weapons, unmanned aerial systems, upgrading naval vessels, and enhancing long range strike power. Taiwan either has already produced some of these items, or the level of technology involved is moderate and achievable by Taiwan with little or no outside assistance. Of course, what Taiwan could produce on its own would be greatly improved if it can source more advanced components from foreign companies to fit onto Taiwan-produced platforms. For instance, Taiwan has successfully developed various indigenous missile systems, but they still must rely on cutting-edge gyroscopes from the United States for accurate targeting.

⁷ Ministry of National Defense (Taiwan), *Quadrennial Defense Review 2017*, 44-45.

Assessing Taiwan's Indigenous Defense Hardware Manufacturing Capabilities

Taiwan's indigenous defense planning is highly centralized around Taiwan's Ministry of National Defense (MND) and three primary state-affiliated defense companies: NCSIST, AIDC, and CSBC. Program managers in these organizations reach out, as needed, to some two hundred small and medium-sized companies within Taiwan for components such as optics, high quality steel, sensors, communication devices, and more. The small companies often supply to the government's defense establishment without knowing to which weapons systems they are supplying to, since private sector employees, for the most part, lack both the necessary security clearance and the need to know.

Many SMEs within Taiwan's indigenous defense industry play important roles in manufacturing advanced new military equipment. Taiwan's Samwell Testing Inc., for example, can design items with computer-aided drafting (CAD), while 3D Printing Technology Company can create the initial small-scale prototypes. Acme Portable Corporation and Harbinger Technology can integrate communications equipment. Avix Technologies can supply aviation parts. BTC Technology Company can supply electrical wires. Getac could provide rugged computers for use in the harsh environments required by the military, while President Company can provide titanium bars and tubes if strong and lightweight components are required. Each of these companies is Taiwanese, and all are among some 200 defense-related companies in Taiwan we examined.

The small and medium-sized enterprises that comprise Taiwan's local defense suppliers capture roughly 3.3% of Taiwan's entire defense budget per year.⁸ Our calculations show that Taiwan's indigenous SME defense industry is worth roughly \$33 million US dollars per year.⁹ This number excludes huge government af-

filiated defense manufacturers NCSIST, AIDC, CSBC that then draw on materials from those suppliers to then research, design, and manufacture military components and weapon systems. In contrast, the most recent and available annual reports for large government-affiliated organizers was a revenue of around \$900 million US dollars for AIDC in 2016, \$500 million US dollars for CSBC also in 2016, and \$900 million US dollars for NCSIST.¹⁰ The grand total of these three large government-affiliated organizations is roughly \$2.3 billion US dollars per year, and adding the SME dollar value has little effect on that number.

Taiwan's small and medium-sized defense companies are concentrated in the capital city Taipei, unsurprising given that Taipei is home to nearly 10 percent of Taiwan's total population of 23 million. Taipei is also a center for international business, unlike other major Taiwanese cities such as Taichung, Tainan, and Kaohsiung. Other than Taipei, defense contractors are also clustered around the three main state affiliated defense companies—NCSIST in Taoyuan, AIDC in Taichung, and CSBC in Kaohsiung. There are few defense companies outside of Taipei, Taoyuan, Taichung, and Kaohsiung counties. Noteworthy defense industrial areas outside of these hot spots include Hsinchu for information technology firms, Air Asia in Tainan, shipbuilding components in Pingtung, and Lung Teh Shipbuilding in Yilan. The heat map below reflects the distribution of defense companies, but only 88 out of approximately 200 had detailed information.

Just as small and medium-sized enterprises will play an important role in any future Taiwanese indigenous defense projects, so too will international partners. Next, we turn to the role foreign defense contractors have played and will play in Taiwan's efforts to build a robust armed deterrent.

⁸ The subset \$33 million per year for only SME indigenous defense divided by \$10 billion total defense budget equals 0.3% of the defense budget.

⁹ Ministry of National Defense (Taiwan), *National Defense Report 2017*, 120: "To nurture the domestic defense industry, through a military hardware research, manufacture, and maintenance mechanism, a defense industrial supply chain with private enterprise participation has been built. In the last five years the amount of outsourced research, manufacture, and maintenance has totaled over NT \$5.01 billion." Over NT \$5 billion is equal to \$168 million US dollars, which spread over the past five years would be \$33 million US dollars per year on average.

¹⁰ Aerospace Industrial Development Corporation, "2017 Annual Shareholders' Meeting Handbook," 18, https://www.aidc.com.tw/Content/File/shareholder_e106b.pdf; CSBC Corporation, "Consolidated Financial Statements and Report of Independent Accountants," *Morningstar* (December 31, 2016 and 2015): 10, <http://quote.morningstar.com/stock-filing/Annual-Report/2016/12/31/t.aspx?t=XTAI:2208&ft=&d=8d352369cb7ec61e08406e5674bc9b5>; National Chung-Shan Institute for Science and Technology, "2017 Final Report," <http://www.ncsist.org.tw/cisistdup/aboutus/page07.html>

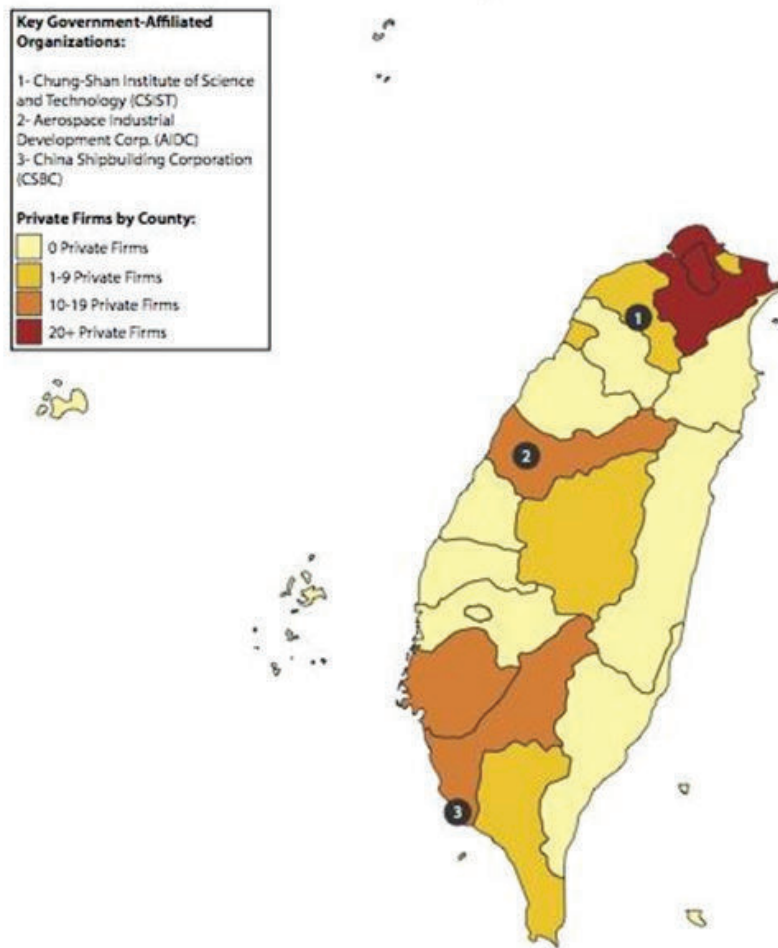


Figure 3: Heat map of 88 private companies that supply components into Taiwan's indigenous defense programs

International Collaboration

The Taiwan Ministry of National Defense's international military hardware cooperation with the United States and other partners can be separated into three levels:

- High: Co-creation of new and original technologies within Taiwan
- Moderate: Co-production of commercially available systems in Taiwan
- Basic: Purchase of complete COTS weapons systems for transfer to Taiwan

The most well-known examples of Taiwan's companies working with foreign partners to create new systems are Taiwan's IDF aircraft in the 1980s, and Taiwan's plans to produce an IDS. There are numerous examples of Taiwan purchasing finished and complete US, Israeli, and French military hardware to be shipped to Taiwan.

Taiwan Ministry of National Defense

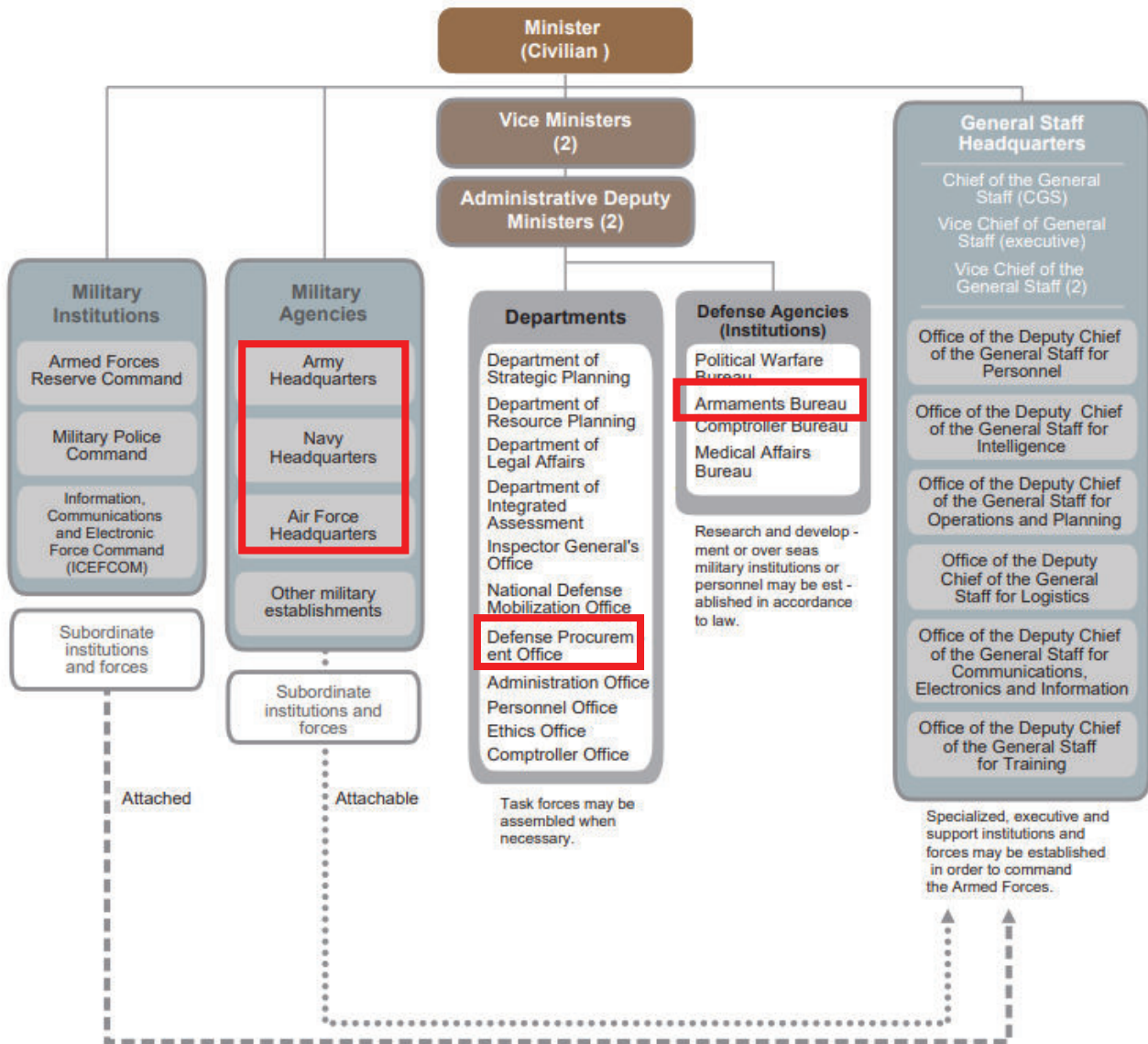


Figure 4: Taiwan Ministry of National Defense organizational chart with offices responsible for indigenous development, co-production, and arms imports outlined in red.¹¹

¹¹ Ministry of National Defense (Taiwan), *National Defense Report 2017*, 70.

Developing New Technologies: Indigenous Fighter Aircraft and Submarines

The Indigenous Defense Fighter aircraft was born out of collaborations between Taiwan and multiple US companies. Starting in 1982, Taiwan cooperated with several US defense companies to design its F-CK IDF aircraft. The lead contractor was General Dynamics, which worked closely with Taiwan's AIDC.¹² The earlier variant F-CK-1 A/B airframe was devel-

oped with US company General Dynamics, and it was based on the US' F-16 aircraft.¹³ The original radar for the aircraft was the GD-53, a slightly upgraded version of the General Electric APG-67 radar.¹⁴ To design the engines, AIDC worked with Allied Signal Aerospace Garrett Engine Division, now a part of Honeywell.¹⁵ The avionics were developed with Westinghouse, while the weapons systems were locally produced in Taiwan.¹⁶

Aerospace Int'l Development Corp.

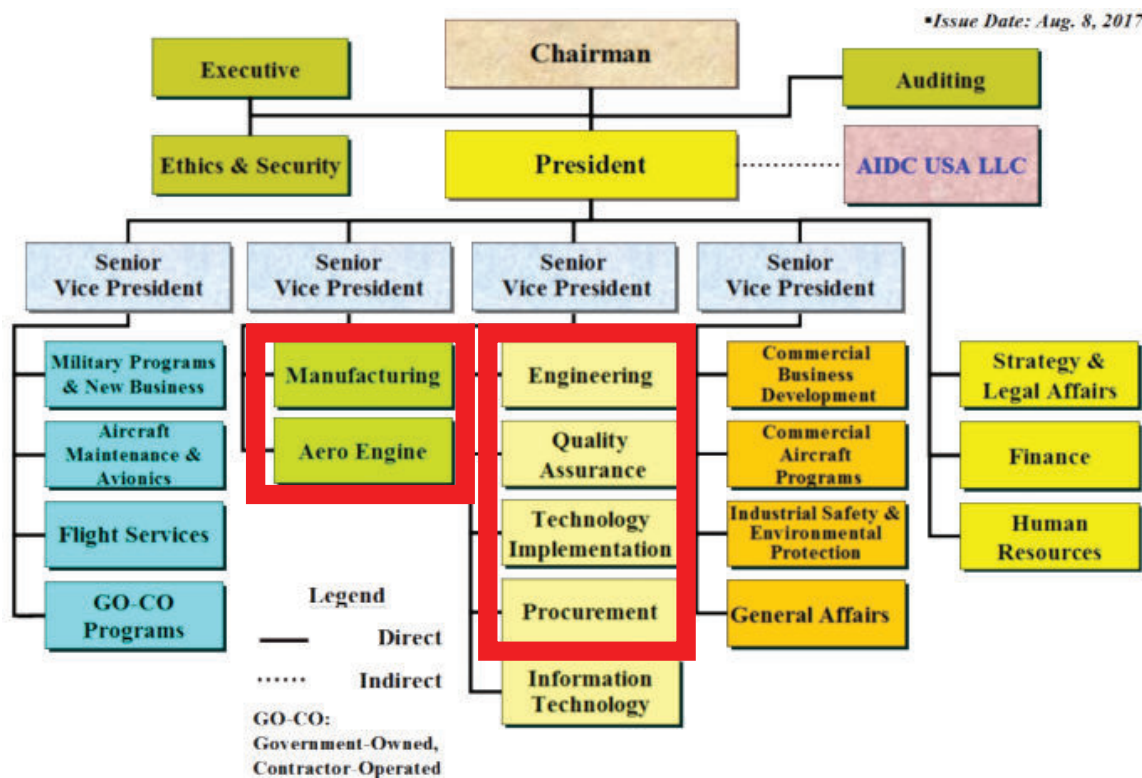


Figure 5: AIDC organizational chart with offices responsible for indigenous development in red boxes.¹⁷

¹² Tim Ferry, "The Future of Taiwan's Defense Industry: Submarines and Drones, American Chamber of Commerce in Taipei," *Taiwan Business TOPICS*, February 16, 2016, <https://topics.amcham.com.tw/2016/02/future-of-taiwan-defense-industry-part-2-submarines-drones/>

¹³ "Ching-kuo Indigenous Defense Fighter," *GlobalSecurity.org*, <https://www.globalsecurity.org/military/world/taiwan/idf.htm>

¹⁴ "Ching-kuo Indigenous Defense Fighter," *Federation of American Scientists*, <https://fas.org/man/dod-101/sys/ac/row/idf.htm>

¹⁵ Tim Ferry, "The Future of Taiwan's Defense Industry,"

¹⁶ Ibid.

¹⁷ "Organization chart," *Aerospace Industrial Development Corporation (AIDC)*, https://www.aidc.com.tw/en/en_sp.asp?navitem=101&secitem=105

Out of the three levels of cooperation, working together with foreign countries and companies to develop new technologies is the most promising opportunity for Taiwan's domestic suppliers. Taiwan's small and medium-sized domestic defense companies can be inserted into the supply chain during the design phase, which is possible but less likely to occur through co-production, and impossible for a simple arms import purchase. According to a former Taiwan National Security Council official, a Taiwan military official can act as the program manager, sourcing components from local Taiwan companies, which supply the items but do not possess information on the military program to whom they are supplying.¹⁸

In 2001, the George W. Bush Administration notified Congress that it would help supply Taiwan with eight diesel electric submarines, but those plans were not fulfilled. After more than a decade and a half of waiting, Taiwan has decided to press forward with its own development of submarines; but it will require help from others. A November 2014, seminar on the indigenous defense submarine (IDS) program brought experts from the United States, Germany, France, Sweden, the Netherlands, Italy, and Australia to Taiwan to discuss plans for Taiwan to develop its own submarines.¹⁹ In a December 2014, hearing with Taiwan's Legislative Yuan's Foreign and Defense Affairs Committee, Vice Admiral Kao Tein-chung shared his view that the best approach for the IDS is to build submarines in Taiwan with the technical support of the United States.²⁰

If Taiwan has its way, the IDS submarine design and manufacturing process will likely resemble the IDF aircraft manufacturing process. While the United States approved "marketing" licenses for US companies to share information about submarine components, it has yet to approve "export" licenses to allow transfer of submarine components to Taiwan. If the

US moves forward with export licenses, then the IDS could resemble the IDF: where Taiwan worked with the US' General Dynamics to build the IDF airframe, an early plan was for Taiwan to work with US submarine manufacturers General Dynamics Electric Boat, Tenneco Inc., or Huntington Ingalls Industries to build the submarine hull.²¹ In 2002, when the US Navy held a discussion with Taiwan officials on manufacturing submarines, the companies that expressed interest in being the prime contractor included General Dynamics, Northrop Grumman, Lockheed Martin, and Raytheon.²² The design work would presumably be contracted to a US company, with the actual manufacturing conducted in Taiwan by the state-owned CSBC Corp., with assistance from the government's Ship and Ocean Industries R&D Center (SOIC) in Tamsui, and foreign partners.²³

Any number of US companies among hundreds could supply the advanced military communications and other electronic components that would be fitted on the hull. Taiwan should try to keep its own indigenous defense companies in mind while sourcing advanced components. However, judging from our review of dozens of Taiwan's small and medium-sized defense companies (see appendix), it is more realistic that Taiwan's many defense companies would supply non-sensitive components such as wiring, high quality steel, or low-to-moderately advanced items such as the propeller and hull.

18 Former Taiwan defense official interviewed by GTI researchers, August 9, 2017.

19 Seth Cropsey, "The Master Plan to Upgrade Taiwan's Military: New Submarines," *The National Interest*, November 12, 2015, <http://nationalinterest.org/blog/the-buzz/the-master-plan-upgrade-taiwans-military-new-submarines-14327?page=2>

20 Ibid.

21 Eric Schmitt, "2 Submarine Makers Vie for a \$60 Billion Project," *The New York Times Archives*, May 17, 1995, <http://www.nytimes.com/1995/05/17/us/2-submarine->

Huntington Ingalls Industries, April 29, 2017, <http://newsroom.huntingtoningalls.com/releases/submarine-indiana-ssn-789-christened>

22 Seth Cropsey, "The Master Plan to Upgrade Taiwan's Military."

23 Tim Ferry, "The Future of Taiwan's Defense Industry,"

Co-Production in Taiwan

Foreign countries and companies can also choose to work with Taiwan to co-produce military equipment within Taiwan. The level of cooperation involved is not as close as in R&D of original technologies, but it still does involve Taiwan to a greater extent than simply receiving equipment shipped from overseas. In co-production, Taiwan pays a foreign company for a license to manufacture a certain number of items. This keeps Taiwan intimately involved in the manufacturing process, and creates jobs for local residents.

Israel has allowed Taiwan to co-produce missiles, fast missile boats, and aircraft components starting in the 1980s. It granted a license for local production of Gabriel 2 missiles and launchers, which Taiwan renamed Hsiung Feng.²⁴ By 1989, over 523 missiles and 77 launchers were produced. Israel also provided a license to Taiwan to produce 50 Dvora fast missile boats locally known as Hai Ou.²⁵ In addition, Taiwan's IDF have been upgraded by installing Israel's El Op's head-up display (HUD).

Arms Purchases from Overseas

Arms purchases—a simple transaction wherein Taiwan pays for arms shipments from a foreign company—constitute the most basic form of military equipment cooperation. There is no research and development collaboration, and no co-production of the equipment in Taiwan.

In just the past ten years, a time period covering the two terms of the Ma Ying-jeou and Obama administrations, the United States has sold nearly \$14 billion in arms to Taiwan. The amount is staggering in light of the several decades prior. These recent arms sales included Apache helicopters, Patriot Advanced Capability (PAC-3) missile defense systems, and advanced radar systems. The arms sales that congressional notification confirmed in December 2015 was valued at US \$1.83 billion and included Perry-class frigates,

the Phalanx Close-In Weapon System, the advanced Tactical Digital Information Link, Assault Amphibious Vehicle-7 (AAV), and other weapons systems. The latest arms sales congressional notification, in June 2017 included Surveillance Radar Program operations and maintenance, joint standoff weapon (JSOW) missiles, upgrades to the electronic warfare system in Kidd-class destroyers, lightweight torpedoes, heavyweight torpedoes, Standard Missile 2 (SM-2), and High Speed Anti-Radiation Missiles (HARM).²⁶

The Netherlands supplied Taiwan with two of its four submarines. The two are Jianlong-class (modified Dutch Zwaardvis-class) vessels acquired from the Netherlands dating to the early 1970s, and the other two are World War II-era Haishih-class (US Guppy II-class) submarines.²⁷

France has also provided Taiwan with Mirage fighter aircraft and Lafayette-class frigates. In 1992, Taiwan accounted for half of France's total overseas weapons sales, which included the Lafayette frigates and Mirage fighters.²⁸ By one account, the deal with France was a roundabout way to acquire advanced fighter aircraft from the United States. According to Hau Pei-tsun, who was chief of Taiwan's General Staff at the time, “without the Lafayette deal, Taiwan would not have been able to get the Mirage 2000 fighter planes. Without the Mirage deal, Taiwan would not have been able to get the F-16s from the US.”²⁹

The next section of the report looks at the following questions, broken down by service branch: What are the companies that would undertake these projects, and what about their past accomplishments leads us to assess their abilities with such a degree of confidence? Is the defense industry in Taiwan structured in such a way as to meet the challenges it faces, and if not, how could that structure be improved? The branches are examined in order of strong international interest in Taiwan's air programs, then sea-based programs, and land-based military platforms.

24 Yitzhak Shichor, “Israel's Military Transfers to China and Taiwan,” *Survival*, Vol. 40, 1998, <https://www.tandfonline.com/doi/abs/10.1093/survival/40.1.68?journalCode=tsur20>; Richard Bitzinger, “The Globalization of the Arms Industry,” *International Security*, Vol. 19, No. 2, Fall 1994, <https://www.jstor.org/stable/2539199>

25 Ibid.

26 Defense Security Cooperation Administration, “Major Arms Sales: June 2017,” <http://www.dsca.mil/major-arms-sales/archives/201708>

27 Tim Ferry, “The Future of Taiwan's Defense Industry.”

28 Nancy Bernkopf Tucker, *Strait Talk: United States-Taiwan Relations and the Crisis with China* (Cambridge, MA: Harvard University Press, 2011), 188.

29 Nancy Bernkopf Tucker, *Strait Talk*, 188.

Taiwan Air Force

Much of Taiwan's aerial deterrent has been purchased from, or jointly developed together with, foreign suppliers (see "International Collaboration"), yet Taiwan's Air Force (TAF, also known as Republic of China Air Force) has managed to build up, develop, and manufacture an impressive array of homegrown weapons platforms. These homegrown weapons platforms have been driven primarily by NCSIST and AIDC, with non-essential components supplied by an array of smaller domestic suppliers drawn from Taiwan's large base of small and medium-sized manufacturing suppliers.³⁰

Major indigenous weapons platforms fielded by TAF include:

- The Indigenous Defense Fighter
- Missiles (air-to-air, air-to-surface, and surface-to-air)
- Advanced trainer aircraft

AIDC and its predecessor entities have been the lead institutions responsible for IDF design and manufacturing since the program's inception, although for a portion of the program's existence AIDC was a division of NCSIST. Although Taiwan leaned heavily on foreign suppliers for expertise in the early years of the program, its persistence in developing a homegrown fighter has allowed AIDC and NCSIST to accumulate significant expertise across the entire spectrum of necessary technical capabilities, including avionics, structural and engine design, and manufacturing and assembly.³¹ Most facets of AIDC's technical capacity are located in, or near, its headquarters in Taichung, although engine part fabrication, and engine assembly/testing are handled in its Kang-Shan Complex in Kaohsiung.³²

Although publicly available information on the configuration of Taiwan's missile programs is limited, Taiwanese defense experts have confirmed that all significant aspects of missile design and manufacturing are handled in house by NCSIST,³³ most likely at its highly secretive "Systems Manufacturing Center" in New Taipei's Sanxia District.³⁴ It is worth noting that Taiwan's missile seeker heads are also designed and produced domestically by NCSIST.³⁵ NCSIST expertise also appears to be ready to be transferred to the development of a homegrown Active Electronically Scanned Array (AESA) radar for installation in a new generation of indigenous advanced trainer aircraft.³⁶ NCSIST would have overall development responsibility, with airframe development subcontracted out to AIDC.³⁷ NCSIST is also the lead institution for all of Taiwan's indigenous development and production of military drones.

Key Indigenous Capabilities

Indigenous Defense Fighter Aircraft

Conceived in the early 1980s after the Reagan administration refused to sell to Taiwan the F-20 and F-16 fighter jets, Taiwan's IDF was developed domestically at great expense through cooperation with a number of foreign partners (see "International Collaboration"). First flight for the IDF, also designated F-CK-1 A/B, took place in 1989, with an initial planned order of 250, which was eventually reduced to a total order of 130 units, final delivery of which was completed in 1999.³⁸ Plans were mooted to build a successor model with range-extending conformal fuel tanks,³⁹ but Taiwan's Ministry of National Defense eventually opted for a more modest Mid-Life Upgrade program.⁴⁰ The upgraded IDFs, designated F-CK-1 C/D, have improved radar and avionics, and can carry more missiles, including the recently introduced Wan Chien air-to-ground joint standoff weapon (see 'Missiles' below).

30 GTI interview, August 9, 2017

31 Aerospace Industrial Development Cooperation, "Engine Manufacture," http://www.aidc.com.tw/en/en_sp.asp?navitem=103&secitem=302&relitem=3020

32 Aerospace Industrial Development Corporation, "Location," http://www.aidc.com.tw/en/en_sp.asp?navitem=101&secitem=110

33 GTI interview, August 9, 2017.

34 "Mysterious Military Industrial Facility Manufactures Missiles" (in Chinese), *China Times*, February 4, 2015, <http://www.chinatimes.com/cn/newspapers/20150204000399-260102>

35 National Chung-Shan Institute of Science & Technology (Taiwan), "Missile Seeker," http://www.ncsist.org.tw/eng/csisdup/products/products_Middle.aspx?catelog_Id=32

36 "Nationally Produced New Generation of AESA Radar" (in Chinese), *Storm*, February 2, 2017, <http://www.storm.mg/article/220726>

37 Chris Pocock, "Taiwan Confirms Indigenous Jet Trainer Development," *Aviation International News*, February 17, 2017, <http://www.ainonline.com/aviation-news/defense/2017-02-16/taiwan-confirms-indigenous-jet-trainer-development>

38 "Ching-Kuo Indigenous Defense Fighter," *Globalsecurity.org*, <https://www.globalsecurity.org/military/world/taiwan/idf.htm>

39 James Hardy, "Upgrades to keep Taiwan's IDF aircraft operational for another 20 years," *International Defence Review*, August 24, 2011, accessed via janex.ihs.com on August 10, 2017.

40 J. Michael Cole, "Taiwan Unveils 'Wan Chien' Air-To-Ground Cruise Missile," *The Diplomat*, January 17, 2017, <http://thediplomat.com/2014/01/taiwan-unveils-wan-chien-air-to-ground-cruise-missile/>

Air-launched Missiles

More than perhaps any other homegrown Taiwanese weapons platform, Taiwan's missiles stand out as significant technical achievements, with performance specifications that compare favorably with those made by leading foreign arms manufacturers.⁴²

The most recent introduction to Taiwan's aerial missile arsenal is the Wan Chien air-to-ground joint standoff weapon, which entered service in limited numbers in late 2013/early 2014 and is designed for delivery by upgraded F-CK-1 C/D.⁴³ Although, domestically developed, the Wan Chien is believed to be similar in capability to the Raytheon AGM-154A Joint Stand-Off Weapon. A cluster munitions delivery system, it is meant to be fired at targets from up to 200 kilometers away (up to 120 miles), giving it the range to engage inland PRC targets, such as airfields from outside the radar envelopes of most surface-to-air defense systems deployed along China's southeast coast.

Taiwan also fields the domestically developed Tien Chien II air-to-air missile, whose beyond-visual-range performance is comparable to the AIM-120 AMRAAM in a physical package similar to a last-generation AIM-7 Sparrow.⁴⁴ The Tien Chien II A variant, also domestically developed, is an anti-radiation missile (ARM) that could be used to target Chinese surface-to-air missile (SAM) sites in the event of a cross-Straits conflict.

While having developed a respectable defense industrial capability at the systems level, Taiwan continues to rely heavily on foreign supply for critical components, sub-systems, and technology. These include everything from gyroscopes, control servos, electro-optical components, to radar modules, and rocket propellant technology. Many of the key sub-systems such as guidance seekers also come from foreign-supplied designs, technologies, and components. The most prominent example is the active radar seeker used in a number of current NCSIST missiles, which was based on US

technology purchased in the 1980s.

Trainers

Taiwan's order of battle currently includes 46 aged AT-3 advanced trainers.⁴⁵ Developed by ADIC, the AT-3 first saw service in 1986,⁴⁶ with a 2002-2004 upgrade program meant to extend its life to 2017. As of this writing, these 'trainers' are still flying (more than just training aircraft, trainers can provide light fighter support in air-to-air and air-to-ground roles).

However, TAF has long recognized the need for a new generation of advanced trainer, and after a prolonged tender process commissioned an AT-3 successor, designated the XT-5 "Blue Magpie" Advanced Jet Trainer. The design of the new supersonic trainer will be based on F-CK-1, including the same Honeywell engine, but will reportedly carry additional fuel.⁴⁷ Recent reports indicated NCSIST hopes that the aircraft will begin flight testing in 2020, with delivery of the full order of 66 aircraft to be completed by 2026.

UAVs

Despite its significant commercial and academic know-how contributing to a vibrant, growing commercial UAV sector, Taiwan's military application of UAV technology shows the drawbacks of a centralized defense structure that allows limited input by academic and smaller firms.⁴⁸ Taiwan's rollout of military UAVs remains limited. The Ministry of National Defense has deployed the Chung Shyang II battlefield surveillance drone during live fire drills.⁴⁹ While NCSIST has shown a prototype of a medium-altitude long-endurance (MALE) UAV armed with mockup missiles similar in appearance to the Lockheed Martin AGM-114 Hellfire at defense exhibitions.⁵⁰ The drone itself is similar in size and appearance to the General Atomics MQ-9 Reaper. NCSIST also displayed a prototype for an anti-radiation drone similar to Israel's IAI Harop at a recent defense exhibition in Taipei.⁵¹

41 "Taiwan Indigenous Defense Fighter aircraft," photo for public use through creative commons, https://en.wikipedia.org/wiki/File:ROCAF_AIDC_F-CK-1A_Ching_Kuo_Aoki-1.jpg

42 Gavin Phipps, "Taiwan to induct up new stand-off air-launched missile," *Jane's Defence Weekly*, September 20, 2012, accessed via janes.ihs.com, August 10, 2017.

43 Ibid.

44 "Tien Chien II offers an AMRAAM-class performance," *Jane's Missiles and Rockets*, August 30, 2001, https://archive.org/stream/Janes_Missiles_and_Rockets/Janes_Missiles_and_Rockets_djvu.txt

45 Gareth Jennings, "Taiwanese jet trainers cleared to resume flight operations," *Jane's Defence Weekly*, October 30, 2014, accessed via janes.ihs.com, August 10, 2017.

46 Kenneth B. Sherman, "AT-3 upgrade and possible export," *Journal of Electronic Defense*, 25, no. 8 (August 2002), accessed via proquest.com, August 10, 2017.

47 Gavin Phipps, "Taiwan to locally build 66 supersonic trainer aircraft," *Jane's Defence Weekly*, February 8, 2017, accessed via janes.ihs.com, August 10, 2017.

48 World Trade Center Association, "Drone Taiwan to take flight at TADTE 2017," June 29, 2017, <https://www.wtca.org/locations/world-trade-center-taipei/news/drone-taiwan-to-take-flight-at-tadte-2017>.

49 Gavin Phipps, "Taiwan deploys indigenous UAV in live-fire drills," *Jane's Defence Weekly*, December 16, 2010, accessed via janes.ihs.com, August 10, 2017.

50 "Packing a punch [IDEX17D3]," *Jane's 360*, February 21, 2017, <http://www.janes.com/article/67979/packing-a-punch-idex17d3>

51 J. Michael Cole, "Taiwanese Military Unveils New Equipment At Defense Trade Show," *Taiwan Sentinel*, August 17, 2017, <https://sentinel.tw/taiwan-tadte-2017-new/>

National Chung-Shan Institute of Science and Technology (NCSIST)

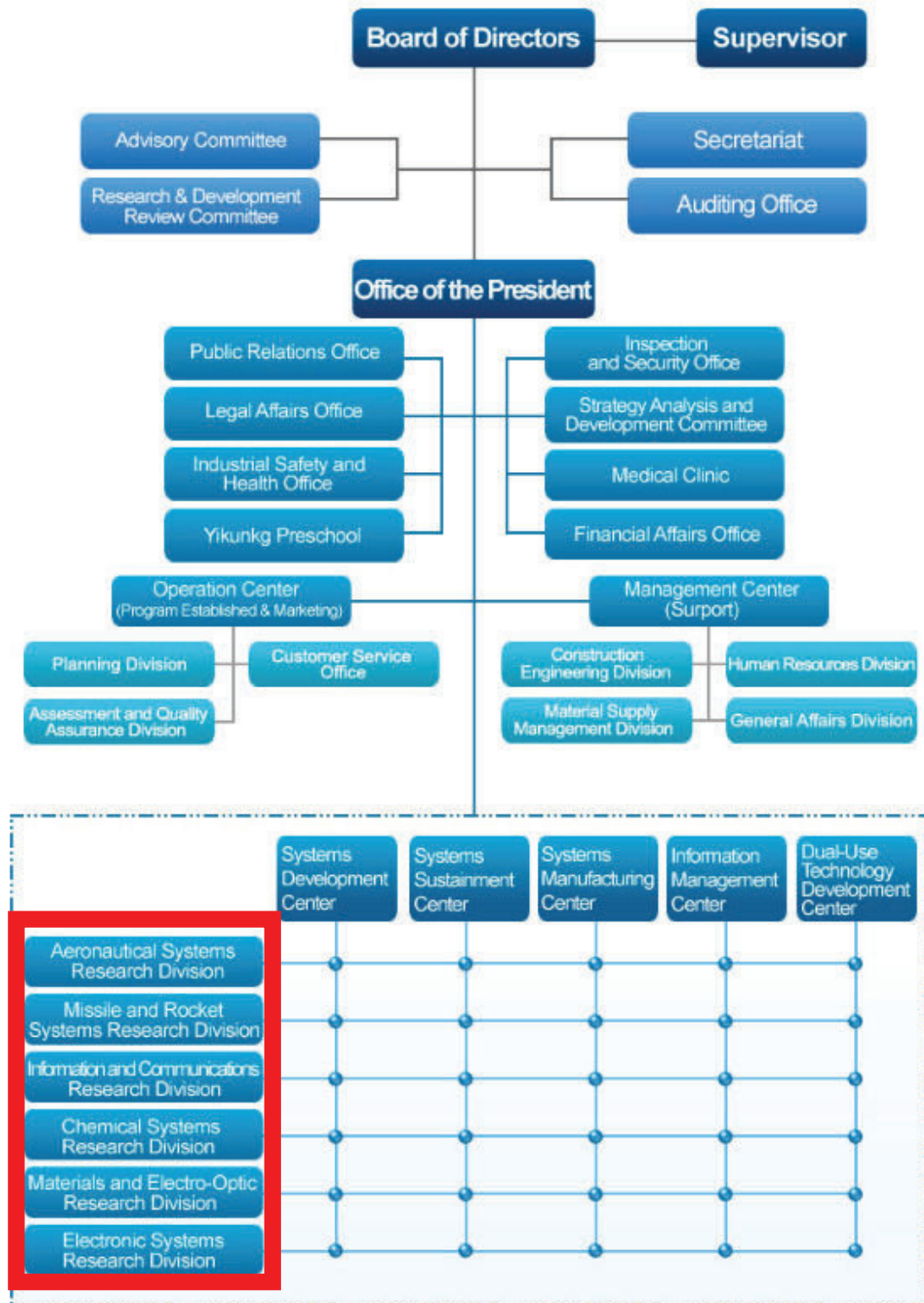


Figure 6: NCSIST organizational chart with offices responsible for indigenous development in red.⁵²

⁵² NCSIST, "Chart of Organization," <http://www.ncsist.org.tw/eng/cistdup/aboutus/page06.html>

Way Forward

The most pressing question for TAF is the preservation of its aerial order of battle. Although there are genuine questions about the potential survivability of a Taiwan fighter force in a high intensity and long duration engagement, Taiwan's government has nevertheless indicated its desire to continue investing heavily in such platforms.

Such investment will be necessary, as Taiwan's complements of Northrop F-5 fighters and Mirage 2000 are nearing retirement, and are no match for the newest generation of PRC fighter aircraft. In addition to the next generation trainer aircraft already announced (see 'Trainers', above), reports indicate that Taiwan's air force will complement its efforts to

acquire F-35 STOVL fighters with a domestically developed next-generation stealth fighter. Despite AIDC's decades of experience, forging partnerships with foreign defense entities will be necessary for such a craft's most advanced components, including stealth.

Additionally, while NCSIST has an active drone development program, sources close to the Taiwanese defense establishment have indicated there is wide dissatisfaction with the performance of the drone platforms introduced to date. Although Taiwanese universities and private companies have significant expertise in this field, Taiwan's lack of a proper security clearance system limits their ability to contribute.

Taiwan Navy

The Taiwan Navy (TN, also known as Republic of China Navy), like the Taiwan Air Force, utilizes an amalgam of platforms and components that have been directly imported from foreign suppliers, produced domestically under license or modified for Taiwan's needs, or indigenously produced. As with most of its defense industry, Taiwan's production of naval vessels has until recently predominantly fallen under the purview of one main state-owned enterprise, in this case now-privatized CSBC Corp., formerly China Shipbuilding Corp, with a number of smaller private firms contributing non-sensitive components. However, Taiwan's naval production industry is distinct from the other military services in that a handful of private firms have recently taken a larger role in the construction of major naval vessels, most notably Lung Teh Shipbuilding.

As with other branches of the Taiwan military, research and development for the Taiwan Navy's combat systems originates with NCSIST. NCSIST works with a number of private firms in Taiwan, and manages the development and production of the indigenous missile systems that arm Taiwan's naval vessels. For the domestic production of the naval vessels themselves, Taiwan's Naval Shipbuilding Development Center takes the lead on warship design and planning.

61 Tim Ferry, "The Future of Taiwan's Defense Industry."

62 Ibid.

Taiwan Int'l Shipbuilding Corp. (Formerly China Shipbuilding Corp.--CSBC)

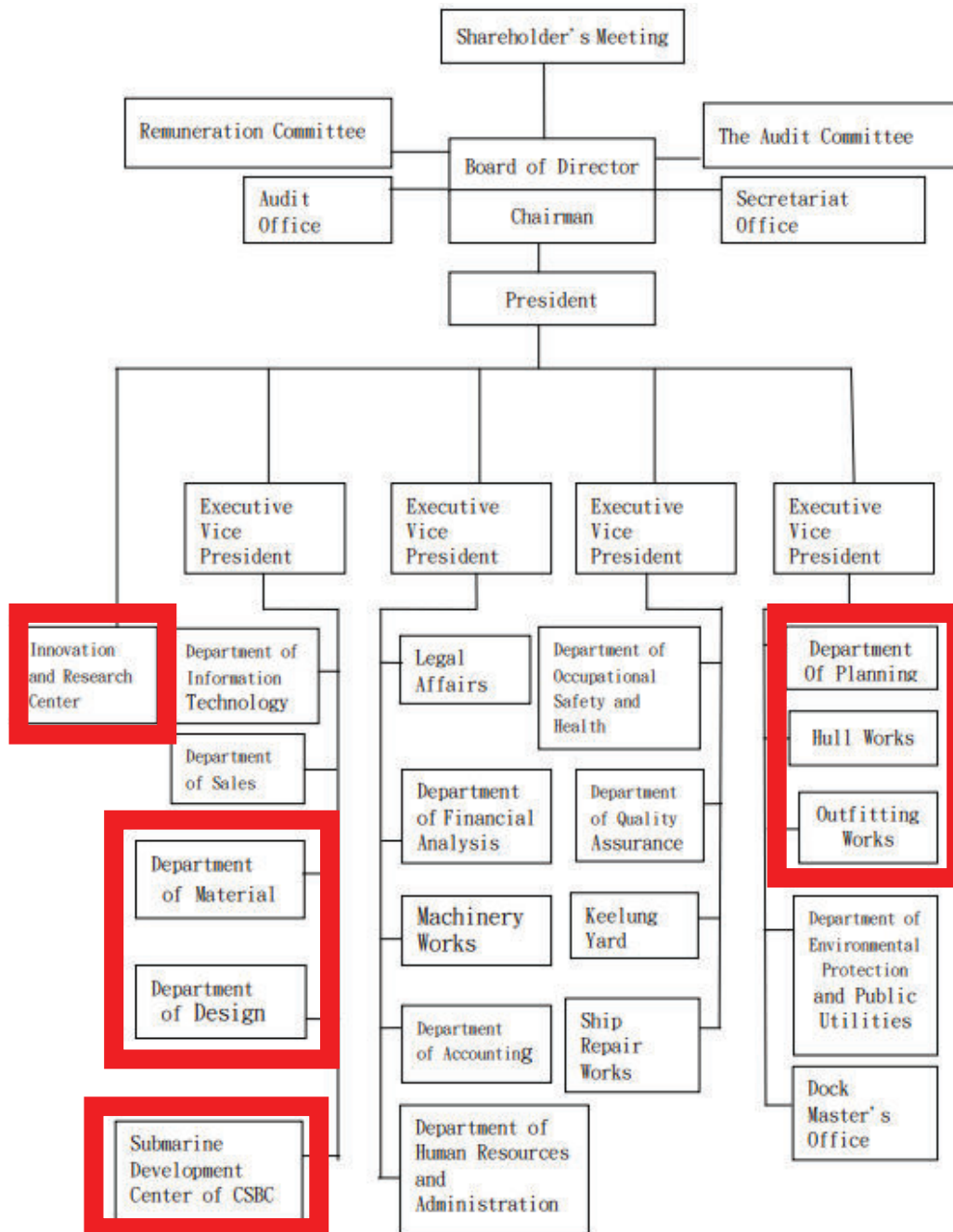


Figure 7: CSBC organizational chart with offices responsible for indigenous development in red.⁶⁹

⁶⁹ CSBC Corporation (Taiwan), "2016 Annual Report," 8, <http://www.csbnet.com.tw/Uploads/2016AnnualReport.pdf>

Key indigenous capabilities

Surface Vessels

CSBC Corp., a state-owned enterprise that was privatized in 2008, has historically performed the bulk of Taiwan's military shipbuilding, although its private manufacture now accounts for a large share of its shipbuilding orders.^{63, 64} CSBC is responsible for the production of the PFG-2 Cheng Kung Class Frigate, the Kuang Hua VI-class missile boat, and coast guard patrol boats.⁶⁵ The Cheng Kung-class is in actuality the US' Oliver Hazard Perry-class frigate, produced under license.⁶⁶ The eight 4,105-ton vessels are mainstays of Taiwan's surface fleet, with the first produced beginning in 1990, and delivery of the final ship taken in 2004.⁶⁷ The 31 ships of the 170-ton Kuang Hua-class, which entered service in late 2010, experienced significant issues in development, with a final product that has been criticized for its seakeeping in rough weather conditions, caused by its light displacement and top-heavy design.⁶⁸

Feasibility studies for a successor began as early as 2007, a program that would eventually grow into the Tuo Chiang-class multi-mission corvettes, built by Lung Teh Shipbuilding in Yilan.⁷⁰ A 500-ton wave-piercing stealth corvette with a top speed reportedly over 40 knots, the Tuo Chiang is claimed by the TN to be "the fastest and most powerful vessel of its kind in Asia." The TN deployed the first of an eventual twelve Tuo Chiang corvettes produced by Lung Teh in 2015, and plans to arm the vessels with Hsiung Feng II and Hsiung Feng III missiles to allow targeting of high-value enemy warships.⁷¹ In April, an unnamed source from within the Taiwan military reported plans for the Taiwan Navy to produce upgraded versions of the Tuo Chiang prototype, with enhanced

weapons platforms that would allow it to engage more effectively with hostile aircraft carriers.

Sea-launched Missiles

NCSIST developed and produces the Hsiung Feng II (HF-2) anti-ship missile, the Hsiung Feng III (HF-3) supersonic anti-ship missile, and a ship-based variant of the Tian Chien II missile, which are installed not only on domestically-produced vessels, but also on modified destroyers imported from the United States and France.^{72, 73, 74}

The HF-2 was first deployed in 1990 as a ship-borne anti-ship weapon with a 100 km (62 miles) range. Air- and ground-launched versions were later introduced, as well as a version launched from a mobile ground launcher.⁷⁵ The supersonic HF-3, a recent introduction to Taiwan's missile arsenal, is a formidable anti-ship 'carrier killer' with a maximum range of between 150 and 250 km (90 to 150 miles). The new Tuo Chiang-class missile corvettes will carry a complement of eight HF-3s apiece.⁷⁶ There have also been reports that an "HF-3ER" extended range version is under development, with a rumored maximum range of 300 to 400 km (180 to 250 miles).



Figure 8: Brave Wind Hsiung Feng III missile.⁷⁷

64 "FBR Asian Company Profiles: CSBC," *LexisNexis Academic*, July 31, 2017, <https://www.lexisnexis.com.proxy1.library.jhu.edu/lnacui2api/api/version1/getDocCui?lni=5KC5-NWG1-F03G-13P6&csi=270944,270077,11059,8411&hl=t&hv=t&hnsd=f&hns=t&hgn=t&oc=00240&perma=true>

65 CSBC Corporation, "Naval Ships," Taiwan, <http://www.csbcnet.com.tw/English/BusinessEng/NavalShipsEng.htm>

66 "Carrier Killer: Taiwan's Tuo Jiang-Class Missile Corvette," *Jane's 360* (2016), http://www.janes360.com/images/assets/163/66163/Carrier_killer_Taiwans_Tuo_Jiang-class_missile_corvette.pdf

67 "Taiwan Accepts Final Frigate," *Jane's Navy International*, March 25, 2004.

68 J. Michael Cole, "China Pans Navy's New Attack Boat," *The Taipei Times*, <http://www.taipeitimes.com/News/taiwan/archives/2012/01/12/2003523049>

69 CSBC Corporation Taiwan, "2016 Annual Report," 8, <http://www.csbcnet.com.tw/Uploads/2016AnnualReport.pdf>

70 Sam LaGrone, "Taiwan Navy Takes Delivery of First Stealth 'Carrier Killer' Corvette," *USNI News*, December 24, 2016, <https://news.usni.org/2014/12/24/taiwan-navy-takes-delivery-first-stealth-carrier-killer-corvette>

71 "Carrier Killer," *Jane's 360*.

72 John Pike, "Hsiung-Feng II," *Global Security*, last modified March 9, accessed August 22, 2017, <http://www.globalsecurity.org/military/world/taiwan/hf-2.htm>.

73 Claudia Liu, and Jay Chen, "La Fayette Frigates' Missile Upgrade Set for 2017," *Focus Taiwan*, November 4, 2013, <http://focustaiwan.tw/news/aip/201311040031.aspx>.

74 Mike Yeo, "Taiwan Receives Two US Navy Frigate," *Defense News*, March 14, 2017, <http://www.defensenews.com/naval/2017/03/14/taiwan-receives-two-us-navy-frigates/>.

75 Center for Strategic and International Studies, "Hsiung Feng II," July 13, 2013, <https://missilethreat.csis.org/missile/hsiung-feng-ii/>.

76 Charles Au, "Taiwan Releases First Firing Footage of HF-3 carrier Killer," *Jane's Navy International*, December 17, 2014, <http://www.janes.com/article/46788/taiwan-releases-first-firing-footage-of-hf-3-carrier-killer>

77 Wikimedia, "Hsiung Feng III Anti-Ship Missile Display" (in Chinese), photograph, October 9, 2011, photo for public use through creative commons, https://commons.wikimedia.org/wiki/File:Hsiung_Feng_III_Anti-Ship_Missile_Display_in_Chengkungling_20111009a.jpg

Way Forward

Taiwan's IDS is undoubtedly the most ambitious of Taiwan's planned indigenous naval weapons programs. Proposals to build a fleet of eight diesel-electric submarines were mooted as early as 2001, but have only recently begun to move towards fruition.⁷⁸ In August 2016, CSBC opened its Submarine Development Center (SDC), with an eye towards the production of Taiwan's first indigenously produced submarines.⁷⁹ CSBC has been contracted to produce eight submarines, the specifications of which are known only approximately;⁸⁰ sources indicate a displacement between 1,200 and 2,400 tons, a top speed of 17 kilotons underwater, and an operating range of 6,000 nautical miles. CSBC reportedly hopes to deliver the first submarine by 2024.

In an interview, Jane's recorded an SDC official as saying that foreign partners will be necessary for a number of the submarines' primary systems, including the main engine, combat management system, sonar, and torpedoes (see "International Collaboration" for more).⁸¹ The United States recently approved a marketing license to allow US defense companies to discuss potential technical assistance for Taiwan's IDS program.⁸² However, Taiwanese companies are vying for a role in other parts of the program. Hung Shan Propeller is preparing a bid based on expertise gained in supplying propellers for eleven of Taiwan's naval warships.⁸³

Taiwan Army

Production of Taiwan weapons platforms and components follows a top-heavy state-run model. As with the rest of Taiwan's defense industry, primary R&D and systems management for the Taiwan Army's (TA, also known as Republic of China Army) arms production is a function of NCSIST. NCSIST produces a combination of US-licensed small arms and armored vehicles; modified small arms platforms based on US designs; and indigenous weapons and armor systems. NCSIST also manufactures some platforms on its own, such as the Thunderbolt-2000 mobile multiple launch rocket system, designed to target disembarking amphibious troops.⁸⁴ Two other organizations under the Ministry of National Defense participate in the manufacturing of small arms, munitions, and ar-

mored vehicles: the 205th Arsenal and the Ordnance Readiness Development Center.

Key indigenous capabilities

Small Arms and Ammunition

The 205th Arsenal in Kaohsiung provides the manufacturing service for Taiwan's small-arms and munitions production. The 205th Arsenal also designs and develops indigenously designed and produced small arms for Taiwan, such as the XT-105 assault rifle, T65 rifle, and T91 rifle.⁸⁵ The T91 rifle, sold through Wolf Performance Ammunition, was the first Taiwan

78 "Taiwan Pushes US Government on Indigenous Submarine Build Plan," *Jane's Navy International*, March 21, 2003.

79 David An, "International Cooperation to Help Build Taiwan's Indigenous Submarines," *Global Taiwan Brief*, 1, no. 4 (October 12, 2016), <http://globaltaiwan.org/2016/10/12-gtb-1-4/>

80 "Taiwan to Build Eight Submarines under Indigenous Shipbuilding Project," *Reuters*, April 5, 2017, <http://uk.reuters.com/article/uk-taiwan-defence-idUKKBN1770CA>.

81 Kelvin Wong, "Domestic Shipbuilders Target Taiwan's Submarine Requirement," *Jane's Navy International*, September 20, 2016, <http://www.janes.com/article/63968/domestic-shipbuilders-target-taiwan-s-submarine-requirement>

82 Shirley Kan, "Saga of Submarines: Licenses in the Newest Episode," *Global Taiwan Brief*, 3, no. 8 (April 1, 2018), <http://globaltaiwan.org/2018/04/vol-3-issue-8/#ShirleyKan04172018>.

83 Hung Shen Propeller, "References," <http://www.hungshenprop.com/>

84 "NCSIST Thunderbolt 2000 Self-Propelled Multiple Launch Rocket System (MLRS) Vehicle," *Military Factory*, June 14, 2017, https://www.militaryfactory.com/armor/detail.asp?armor_id=1018

85 Central News Agency, "Taiwan Unveils Indigenous Next-Generation Assault Rifle," *Taiwan News*, June 4, 2015, <https://www.taiwannews.com.tw/en/news/2749027>

produced small-arms to be sold commercially.⁸⁶ While there is little publicly-available information regarding the workforce and capacity of the 205th Arsenal, it supplied NATO standard rifle ammunition to the United States in 2005 during the war in Iraq, and exports munition to civilian markets around the world through the Wolf brand of ammunition.⁸⁷ The 205th Arsenal, part of Taiwan's Ministry of Defense, was at the time experiencing a problem of excess capacity.⁸⁸



Figure 9: Taiwan Type 86 assault rifle with Type 85 grenade launcher.⁸⁹

Armored Personnel Vehicles

Taiwan's Ordnance Readiness Development Center, located in Nantou County, is responsible for the development and production of Taiwan's armored vehicles, including the new family of CM-32 "Clouded Leopard" armored vehicles.^{90, 91, 92} The CM-32 was designed with the varied terrain of Taiwan in mind, but has recently attracted attention because of supply-chain and contract issues affecting the vehicle's quality.⁹³



Figure 10: Taiwan's Clouded Leopard armored vehicle.⁹⁴

Conclusion

Taiwan's domestic defense industry is more capable than generally understood, with the island able to produce around half of its future equipment requirements with limited or no foreign collaboration. Although Taiwan faces unique security challenges, it is our hope that the preceding analysis has helped demonstrate that—far from being a passive recipient of US military aid—there is much that Taiwan has done and will do on its own to strengthen its capabilities in the event of a cross-Straits military conflict.

International partners will be important to this effort.

Taiwan can completely provide for half of its future military hardware requirements without external assistance, but cannot attain the rest, mostly the most advanced technologies, without international assistance. The island has for a long time designed and produced customized assault rifles for its diplomatic partners, as well as price-competitive ammunition for the US military and civilian market. Taiwan has also produced advanced Hsiung Feng missiles, Clouded Leopard armored vehicles, and Indigenous Defense Fighter aircraft largely on its own, with some

86 Jonathan Chin, "Thousands of T91 Rifles Sold in US in One Day: Report," *The Taipei Times*, April 23, 2017, <http://www.taipeitimes.com/News/taiwan/archives/2017/04/23/2003669273>

87 Noahmax, "Taiwan to Supply U.S. Ammo?," *DefenseTech*, January 11, 2005, <https://www.defensetech.org/2005/01/11/taiwan-to-supply-u-s-ammo/>

88 "Taiwan's King of Weapons: 205 Arsenal" (in Chinese), *China Times*, June 5, 2015, <http://www.chinatimes.com/newspapers/20150605000929-260309>

89 Wikimedia, "Taiwan Type 86 assault rifle," photo for public use through creative commons, https://commons.wikimedia.org/wiki/File:Type_86_carbine.jpg

90 Edwin Hsiao, "Arms Display Shows Taiwan's Firepower," *Taiwan Today*, September 28, 2007, <http://taiwantoday.tw/news.php?unit=10,23,45,10&post=14600>

91 Wendell Minnick, "Taiwan Army's Jingjin Effort Seeks Digital, Smaller Force," *Defense News*, July 19, 2007.

92 John Pike, "CM32 8X8 Yunpao [Cloud Leopard] Armored Vehicle," *Global Security*, November 7, 2011, <http://www.globalsecurity.org/military/world/taiwan/cm32.htm>

93 Jason Pan, "Thirty-Three Indicted in Military Procurement Case," *Taipei Times*, October 9, 2015, <http://www.taipeitimes.com/News/taiwan/archives/2015/10/09/2003629648>

94 Wikimedia, "Taiwan's Clouded Leopard armored vehicle with 105 mm cannon," photo for public use through creative commons, <https://commons.wikimedia.org/wiki/File:Firecar2.jpg>

international assistance. The heat map of Taiwan's small and medium-sized defense industry suppliers confirms that Taiwan's defense industry is highly centralized, concentrated both administratively and geographically around a few institutions with strong ties to the central government. Taiwan has innovated and developed new technologies, so much so that its components have been incorporated into the international supply chain for Patriot missiles.⁹⁵

The United States has been Taiwan's most reliable partner in supplying what it cannot produce on its own, but even US arms sales to Taiwan have not been as routine or consistent as Taipei would prefer. Other international partners have included the Netherlands for submarines and France for fighter aircraft and naval vessels. Taiwan's other possible future partners could include Japan and Australia.

More important than international partners will be Taiwan's own efforts to manage its domestic defense industrial base. Its three major state affiliated companies—CSIST, AIDC, and CSBC—work directly with Taiwan's Ministry of National Defense, and draw on some 200 small and medium-sized companies that supply components such as optics, wires, sensors, communications devices, high quality steel, propellers, and other items for incorporation into Taiwan's indigenous weapons platforms. Expanding the heat map to include the complete set of small and medium-sized Taiwanese defense companies could be a useful subject for future research. In addition, the relationships between MND, the three major state-affiliated companies, and the hundreds of small and medium-sized companies could be a fruitful direction for future research.

To summarize key policy recommendations for Taiwan mentioned throughout this report:

- **Expand the roles of SMEs:** Taiwan's small and medium-sized enterprises are as competitive and technologically advanced as any in the world. Taiwan's indigenous defense development could benefit substantially—becoming less centralized, more agile, and more innovative—by finding ways to better tap this base of domestic know-how. (Page 6)
- **Consider broadening security clearances to include experts in the SME indigenous defense industry:** One of the reasons Taiwan's SMEs are not more deeply involved in the country's domestic defense industry is because they are not trusted to maintain information security. Therefore, one way to create more space for Taiwan's small and medium-sized suppliers to contribute would be through the widespread implementation of a robust security clearance process. This will spur and decentralize defense innovation at the grassroots level. (Page 6)
- **Consider expanding the classified information sharing infrastructure:** Taiwan should implement a classified information network system to incorporate vetted small and medium-sized defense-related companies. This way, company employees can communicate classified blueprints and sensitive updates to Taiwan's government, military, NCSIST, AIDC, and CSBC. This recommendation is consistent across all three military services.
- **For Taiwan's Air Force:** Increase collaboration with the private and university sectors on military UAV development, if and when a security clearance process can be established. (Page 14)

⁹⁵ Luo Tien-pin and William Hetherington, "US missiles to use Taiwanese-developed technology," *Taipei Times*, October 17, 2016, <http://www.taipeitimes.com/News/front/archives/2016/10/17/2003657323>

- *For Taiwan's Air Force and Navy:* If the US approves export licenses for Taiwan's submarine program, ensure the lessons learned by AIDC and NCSIST from the successes and failures of Taiwan's flagship indigenous weapons platform—the IDF—are applied by CSBC Corp. Taiwan as it proceeds with development of an indigenous submarine (see “Navy,” “International Collaboration,” pages 11, 12, 14)

- *For Taiwan's Navy:* Continue to aggressively seek international partnerships in their development of indigenous weapons platforms, particularly in the indigenous submarine program. Source components for its indigenous submarine from larger producers such as the US, Germany, or Japan, since domestic firms would struggle to develop the technology or the budget to wholly provide the R&D necessary to produce an indigenous submarine that is cost-effective.⁹⁶ (Page 12)

- *For Taiwan's Army:* Tailor weapons systems to suit the unique needs of Taiwan's geography and broader deterrent strategy. While the CM-32 armored vehicle program has had its recent public setbacks, there are success stories such as Taiwan's RT-2000 multiple launch rocket system. The development stage of the process is an example of Taiwan successfully using existing components to create affordable weapons systems. (Page 21)

Recommendations for the United States and Taiwan's other security partners:

- Increase interaction between US officials, US military officers, and senior officials of Taiwan's other partner countries with their Taiwan counterparts, and for the United States to assist Taiwan in building out its capabilities in accordance with the Taiwan Relations Act. (Pages 5 and 12)

- Support Taiwan's indigenous defense by providing much needed components that Taiwan cannot manufacture on its own: Taiwan's domestic defense industry is able to produce half of its future equipment requirements, but remainder would require extensive foreign technical support. (Pages 5 to 7)

- The United States should regularize the Congressional notification process for Taiwan arms sales to at least an annual review, or even multiple decisions within a single year occurring as requests arise.

Our research revealed that program managers within MND and the three main state affiliated companies reach out to Taiwan's small indigenous defense companies for components on an as-needed basis, but the small companies' lack of security clearances bars them from knowing the rationale behind the requests, or which exact weapons systems their components will be incorporated into. Our report's main recommendations center on how Taiwan should broaden its security clearances beyond government employees to include private citizens within its defense companies, and to strengthen information security so that the government can communicate with defense companies about weapons plans and designs through secure channels. Implementing these steps will unlock the creative potential of the private sector to approach the government with new weapons platforms and designs, allowing the government to pick and choose the best offer, rather than have small companies supply to programs unknown to them.

⁹⁶ David An, “International Cooperation to Help Build Taiwan's Indigenous Submarines.”

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Appendix II: List of Acronyms:

AESA	Active Electronic Scanning Array (radar)	MND	Ministry of National Defense
AIDC	Aerospace Int'l Development Corp.	NCSIST	National Chung-Shan Institute of Science and Technology
AAV	Amphibious Assault Vehicle	NDR	National Defense Report
COTS	Commerical Off-the-Shelf	PAC-III	Patriot Advanced Capability missile
CSBC	China Shipbuilding Corp. (Renamed Taiwan Int'l Shipbuilding Corp.)	SAM	Surface to Air Missile
HARM	High Speed Anti-Radiation Missile	SDC	Submarine Development Center
HF	Hsiung Feng (Brave Wind) missile	SM	Standard Missile
HUD	Head Up Display	SME	Small and Medium Sized Enterprises
IDF	Indigenous Defense Fighter aircraft (also F-CK)	TA	Taiwan Army
IDS	Indigenous Defense Submarine	TAF	Taiwan Air Force
JSOW	Joint Stand Off Weapon (missile)	TN	Taiwan Navy
MALE	Medium Altitude Long Endurance (UAV)	QDR	Quadrennial Defense Review
		UAV	Unmanned Aerial Vehicle
		V/STOL	Vertical / Short Takeoff Landing (also as STOV/L)

Appendix III: Excerpt of Data on Taiwan's Small and Medium-sized Enterprises within Its Indigenous Defense Industry

Company name	Address in Taiwan	Manufactures	Mil service (AF, N, A)
3D PRINTING TECHNOLOGY CO., LTD.	23511 新北市中和區建康路164號11樓	3D prints composite materials for aerospace, automotive, industrial sectors.	AF, N, A
A & P INSTRUMENT CO., LTD.	235 新北市中和區橋和路90號3樓 3F., No.90, Qiaohu Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)	Industry Laser Equipment, Industrial Automatic Equipment, Laser Diode, Other Sensors, Laser Rangefinder	AF, N, A
ABEN TECH CO., LTD.	台中市西屯區河南路二段262號3樓之1	Modeling and Simulation, Training Equipment, Technical Services	AF, N, A
ACME PORTABLE CORP.	5F, No. 25, Wu Chuan 3rd Road, Wu-Ku Ind. Park, New Taipei City, Taiwan	Communication Equipment, Geographic Information System (GIS), Server, Embedded Computer & System	AF, N, A
ADLINK TECHNOLOGY INC.	新竹縣竹北市文興路一段156號2樓: 台中市西屯區河南路2段262號12樓之2(中港長鴻大樓); 71019台南市永康區中華路 1-5 號 6A	Rugged COTS computer systems to meet the rugged environments in military	AF, N, A
ADVANCED INTERNATIONAL MULTITECH CO., LTD	No. 2, South 5th Road, Kaohsiung 812, Taiwan	Aviation Parts & Accessories, hot-melt procedure and carbon composites finished structures with fire retardant prepregs	AF, N, A
AEROVISION AVONICS, INC.	2F, 30, R&D Rd. II, Science-based Industrial Park, Hsinchu, Taiwan	Aviation Accessories, Other Aviation Parts, LCD Monitor, Embedded Products.	AF, N, A
AIDC/AEROSPACE INDUSTRIAL DEVELOPMENT CORPORATION	407 臺中市西屯區漢翔路1號; 820 高雄市岡山區大莊里崗德路1號; 433 臺中市沙鹿區中清路六段366號	R&D, system integration, manufacturing and refit of military aircraft, helicopter	AF
AIRASIA COMPANY LTD.	No.1050, Jichang Rd., Rende Dist., Tainan City 71755, Taiwan (R.O.C.)	Aircraft Maintenance, Repair and overhaul	AF
ALL-WINNING CORP.	台北市長安東路二段230號5樓	Impact Tester, Universal Materials Testing Machine	AF, N, A
ALLJACK TECHNOLOGIES, INC.	No.71, Wuquan 7th Rd., Wugu Dist., New Taipei City 248, Taiwan; No.119-1, Wugong 3rd Rd., Wugu Dist., New Taipei City 248, Taiwan	Lathe, Milling Machine, Die Casting, Surgical Instrument, Camera & Photo, Fiber Optical Connector, Aviation Parts & Accessories, Weapons, Parts & Accessories	AF, N, A
APEX FLIGHT ACADEMY	Headquartered in Neihu district, Taipei, Taiwan, with its flight training base located in Taitung (Fong Nien) Airport	Aircraft flight training in Taitung	AF
AVIX TECHNOLOGY INC.	41146 台中市太平區精美路148號	Aviation Parts & Accessories, Other Aviation Parts, Aircraft, Aircraft	AF
BENTECH COMPUTER CORP.	No. 23, Lane 169, Kangning Street, Xizhi District, New Taipei City, 221	Ground control software, computer board, module, components	AF, N, A
BTC TECHNOLOGY COMPANY	台南市公園南路 71 號 2 樓	Lightening Arrester, Electric Wires and Cables, Surge Protector, Lightning Arrester, High Voltage Shielded Cable,	AF, N, A
CENTURY TRADING CORPORATION	台灣 242 新北市新莊區五權一路1號3樓之5	Tool Holder, Cutter Inspection & Measurement, Oil Mist Collector, Milling Cutter, Other Machine Tool Accessories	AF, N, A