

## A Strategic Challenge In China's New Tactical Fighter Exports

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February 7, 2012

As part of its campaign to build global strategic influence China is offering increasingly sophisticated weapons exports that it uses to reinforce important political and economic relationships. China is no longer a last resort supplier of cheap but obsolete weapons for isolated regimes; it can now offer a full range of weapons that are increasingly competitive with Western systems in capability and very competitive in terms of price. This increase in both capability and value is creating new weapons sales opportunities for China in non-traditional regions. This dynamic is starting to play out in Latin America, where China's success in selling inexpensive training aircraft and radar could lead to sales of more sophisticated air combat systems.

China's offering higher capability and greater value in combat aircraft exports is exemplified by the Chengdu FC-1 *Xiaolong* multirole (capable of offensive and defensive missions) lightweight fighter, a co-development/production program with Pakistan, where it is known as the JF-17 *Thunder*. In the FC-1, Chengdu is seeking to offer a new lightweight fighter that approaches the performance of Western 4<sup>th</sup> generation multi-role fighters like the Lockheed-Martin F-16, but which can be acquired for about one-third the cost. This price advantage is enhanced by China's willingness to offer favorable financing. In contrast to Western fighters like the F-16, the FC-1 offers a world-class capability at the beginning of its service life, with upgrades that likely will feature improved electronics, a new engine, and increased stealth features. When armed with advanced Chinese-made precision and stand-off weapons the FC-1 could prove a troublesome threat to U.S. forces and to those of its friends and allies.



Seen at the November 2011 Dubai Airshow, this model of the Chengdu FC-1 shows its multi-roll potential, being armed with 2x PL-12 medium range AAMs, one YJ-82K anti-ship missile and an electronic warfare pod. This view also shows the FC-1's latest airframe modifications: large leading edge extensions (LERX) and diverterless supersonic intakes (DSI). Source: RD Fisher

While the FC-1 has not yet been sold beyond Pakistan it has attracted interest in Algeria, Azerbaijan, Bangladesh, Congo, Egypt, Iran, Nigeria, Myanmar, Sri Lanka, Sudan and Zimbabwe. It has reportedly been considered by Venezuela, which has also purchased Chinese jet trainers, medium transport aircraft, and long-range radar. Sales success with Venezuela might influence other Latin states to consider the FC-1 or other Chinese combat aircraft. Such a development would enable China to develop deeper strategic relationships in the Western Hemisphere as well as strengthen its position to help insure the survival of anti-democratic/anti-U.S. regimes in the region.



Venezuela may be on its way to purchasing close to 40x K-8 trainer and light attack aircraft. Here a Venezuelan K-8 is seen with PL-5 AAMs—the first such Chinese AAM export to Latin America.

Source: Internet

In the past the U.S. sought to limit the sale of advanced weapons in the region, an ability that has eroded over the last two decades as Cold War tensions evaporated, U.S. focus on the region has waned, and Latin economies have grown. The Latin combat aircraft market has diversified as advanced combat aircraft and related technologies have been sold by Russian, European, Israeli and South African companies. As Latin states become more dependent commercially on Chinese markets, the purchase of Chinese weapons could become a critical part of their relationship with another superpower, one that lacks the regional historic baggage of the United States. If it is to limit growing Chinese military influence the U.S. may have to offer better positive incentives, such far less expensive yet capable weapons systems that could better compete with China's wares.

### **China's New Arms Exports**

As a result of 1998 military reforms that eschewed consolidation of its military design and production sector, in favor of enhancing competition, China is now able to offer world class and price competitive military systems from satellites to short-range ballistic missiles to submarines. Many new weapons are not acquired by the People's Liberation Army (PLA) but are offered for export. They are promoted more heavily by China's state-controlled arms export companies which have greatly increased their global profile by participating in major international arms exhibitions (Paris, Farnborough and IDEX in

Abu Dhabi), and increasingly, in smaller regional exhibits (Brazil, Chile, Malaysia, Peru and South Africa). China has significant incentive: arms sales are needed increasingly to subsidize its large and redundant arms sector.

“Traditional” Chinese customers, such as Pakistan and Iran, have been early purchasers of many new Chinese weapons. But since the middle of the last decade China has made more aggressive efforts to sell its new military systems in new markets, with an emphasis on Africa, the Middle East, Southeast Asia and Latin America. As has been the case with previous global powers, China has found that arms sales prospects tend to improve in regions where its economic and political influence is more established and increasingly accepted. To make their weapons more attractive Beijing is often ready to offer “soft” loans to subsidize its arms sales. Bolivia’s early 2011 \$58 million purchase of Hongdu K-8 training/light attack jets was reportedly largely covered by a Chinese government loan.<sup>1</sup>



In May 2011 Bolivian President Juan Evo Morales welcomed the delivery of Hongdu K-8 trainers to the Bolivian Air Force.

In terms of aerospace systems, China has had some success in marketing its communication satellites, and sold its first surveillance satellite to Venezuela in 2010. But not until recently has it been able to offer combat aircraft with world class capabilities. China is on the cusp of curtailing its reliance on Russian turbofan engines, but developing requisite foreign confidence in new Chinese engines may take several more years. China can also offer world-class radar and electronic systems, to include active electronically scanned array (AESA), fully “glass” cockpits and defensive electronics. It can also offer modern weapons, to include self-guided beyond visual range (BVR) and helmet-sighted air-to-air missiles (AAMs), laser and navigation satellite guided bombs, and long-range anti-ship and ground attack missiles. Chinese combat aircraft can be supported by two types of airborne warning and control (AWACS) aircraft. Fairly soon, these aircraft and weapons will also be supported by China’s *Compass* global navigation satellite system, giving them very high precision. In addition,

China can offer sophisticated long-range radar and 4<sup>th</sup> generation surface-to-air missiles to complete an air defense network.

### Chengdu's FC-1 Lightweight Fighter Program

The FC-1 program emerged from the Chengdu Aircraft Corporation's desire to develop a follow-on lightweight fighter to its J-7 family, and Pakistan's desire for greater self-sufficiency in combat aircraft. This program also tracked with India's effort from the mid-1980s to build an indigenous modern lightweight fighter to succeed its Soviet-designed MiG-21 fleet, later called the *Tejas*. Ironically, the eventual FC-1/JF-17 design began as a 1984 cooperative program between Pakistan, China and the U.S. Grumman Corporation to develop a much improved version of the Chengdu J-7M called Project Sabre II.<sup>2</sup> Its major modification was a redesigned fuselage with side-mounted engine air intakes to allow a larger radar to be placed in the nose. Pakistan withdrew from this program in early 1989, so Grumman sought to continue it with the China National Aero Technology Import and Export Corporation (CATIC), and it was renamed the *Super-7*. This phase saw further refinements to the fuselage and wing that took it closer to the final FC-1 design. But Grumman's participation ended following the George H.W. Bush Administration's imposition of arms sanctions following the June 1989 Tiananmen Massacre.



A JF-17/FC-1 fighter on display at the 2011 Dubai Airshow, with a selection of anti-air and anti-surface weapons. Source: RD Fisher

However this did not stop this program. During the 1990s three developments lifted the FC-1 to success. First, the program was joined by engineers from the Russian Mikoyan concern, who provided further design refinements and helped with the integration of a new engine, the Klimov RD-33, called RD-93 in its variant for the FC-1. A second development was that Chengdu started to apply lessons learned from its J-10 4<sup>th</sup> generation fighter program to the design of the FC-1. This effort was led by Dr. Yang Wei, who has gained more recent fame as the Chief Designer of Chengdu's "J-20" 5<sup>th</sup> generation fighter, but who is still very involved with the FC-1 program. The J-10, in turn, benefitted from numerous Russian and Israeli design inputs plus the use of French CATIA digital design programming. The first FC-1 prototype flew in September 2003,

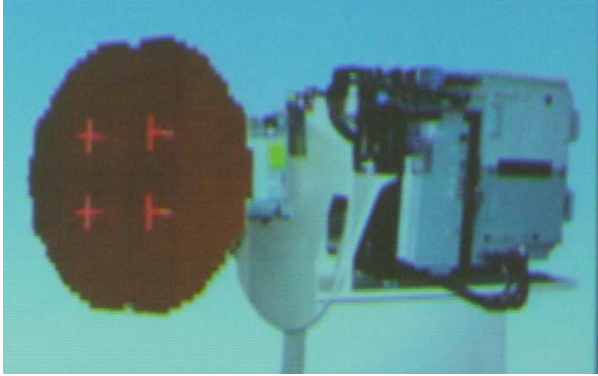
about five years after the first flight of the J-10 in March 1998. The definitive 4<sup>th</sup> prototype, with a redesigned wing with larger leading root extensions (LERX) and diverter-less supersonic intakes (DSI) for the engine, first flew in May 2006.

A third development was especially crucial given that PLA has so far opted not to acquire the FC-1: a 1998 agreement in which Pakistan became a 50/50 development partner and the first major co-producer of this fighter. Pakistan's participation provided much needed financial support and turned the FC-1/JF-17 into China's most advanced combat aircraft technology transfer program as well, a critical consideration for many states looking to upgrade or sustain their domestic combat aircraft production capability.<sup>3</sup> In March 2007 the first JF-17s were delivered to Pakistan and the first batch of 42 began co-production at the Kamara factory in 2009, with delivery expected by early 2012. While sources differ, it is possible that Pakistan could eventually purchase 250 to 300 JF-17 fighters in multiple versions, or "Blocks," along with a twin-seat version.

### **Impressive Capability for the Price**

In the FC-1 Chengdu has not chosen to emphasize dominant performance, but has sought to combine an impressive multi-role capability with a more impressive price. It does so first by aiming for a lower weight class, 12-13 tons vice the 20+ tons for the F-16 and comparable 4<sup>th</sup> generation fighters. The FC-1 also cuts costs by accepting a lower 8-to-8.5G airframe maneuverability stress, which is very good, but slightly less than the 9G design stress for the F-16. While the F-16 can carry twice the payload of the FC-1, this advantage is ameliorated by the high accuracy of smaller Chinese precision-guided weapons. For air combat missions they have a very similar range and, like the F-16, later versions of the FC-1 will be equipped for aerial refueling to extend their range. In short, the FC-1 is not an F-16, but it approaches that performance for a lower price, providing an attractive option for states that cannot afford new F-16s, or would be denied them by Washington. For Pakistan, the FC-1/JF-17 allows an efficient maintenance of a large number of capable fighters to sustain an aerial deterrent of India, but perhaps for poorer countries like Bolivia the FC-1 could enable easier access to an effective air combat capability.

**Airframe.** To keep costs down the FC-1 makes minimum use of expensive composite materials, relying mainly on aluminum, which also eases maintenance costs. The FC-1 only uses expensive digital "fly-by-wire" control technology in the pitch axis, which better exploits the wing's large LERX structures, to provide a better center of gravity and allow the LERX to increase lift at high angles of attack to improve combat maneuverability. The air intake was redesigned to feature a diverterless supersonic intake (DSI), the second fighter to do so after the Lockheed-Martin F-35; this offers a simpler and lighter structure for reducing the speed of air going to the engine, and it has stealth benefits.



The NRIET KLJ-7 radar is derived from that used by the Chengdu J-10A fighter, and has an air-to-air range of about 105km.

Source: Chengdu Aircraft Co. via RD Fisher

**Electronics.** While Pakistan had at one point sought the Italian Grifo radar for the JF-17, it settled on the Chinese Nanjing Institute of Electronics Research Technology (NRIET) KLJ-7 radar, a smaller version of the radar used by the J-10A. This multimode (air-to-air and air-to-ground) X-Band radar has an advertised range of about 105km in the air-to-air mode, can track 10 targets simultaneously, and then attack two targets simultaneously<sup>4</sup> with self-guided BVR AAMs. Though an early 1990s level of capability for the U.S., it remains a respectable capability for the price. The cockpit features three modern multi-function digital displays and the pilot has an option for a helmet-mounted-sight (HMS), which can aim off-boresight AAMs, although Chinese sources say a more complex helmet-mounted display (HMD) may be available.<sup>5</sup> For ground attack the FC-1 can carry an electro-optic targeting pod to guide laser or navigation satellite guided munitions. The FC-1 uses a stabilizer-mounted pod for defensive electronics and can carry a dedicated electronic warfare pod under its wing.

**Engine.** The heart of the FC-1 is a single 18,973 lb (8.5-ton) thrust Klimov RD-93, a modified version of the RD-33 engine developed for the MiG-29 fighter. As with the J-10, the lack of an adequate Chinese engine forced an early reliance on a Russian engine, which in the recent past has threatened the FC-1 program. In 2008 it appeared that India tried to use its leverage as a large MiG-29 customer to convince Russia not to allow RD-93 sales to Pakistan. Nevertheless, China's Guizhou Aeroengine Company has been developing a 9.5-ton thrust turbofan sometimes called the WS-13. In 2010 this engine was revealed to have an axisymmetric thrust vectoring system. Reports indicate that a FC-1 with a Chinese engine started tests in March 2010.<sup>6</sup> A Chinese source has suggested more information about this engine would emerge in 2012.<sup>7</sup> The new Chinese engine will likely require a few more years of refinements before it can be offered for export, but its advent will make FC-1/JF-17 a truly viable export program free from threats of Russian engine denial.



In November 2010 the Gas Turbine Establishment revealed this 9.5-ton thrust turbofan, which could be the WS-13 long reported under development by the Guizhou Aeroengine Company. This engine would turn the FC-1 into a fully viable export program

**Weapons.** The FC-1's ability to employ modern Chinese weapons is a significant equalizer with competing aircraft in its class. For example, use of a helmet-sighted AAM can quickly compensate for a marginal deficiency in aircraft maneuverability because targeting the AAM is not dependent on aircraft maneuvering, but simply the ability of the pilot to see the target. China's Luoyang PL-8 and PL-9C AAMs are equipped for helmet sighting. The long expected Luoyang "PL-10" short range AAM will feature higher off-boresight and maneuvering capability, perhaps approaching that of modern Western AAMs like the Raytheon AIM-9X and the British ASRAAM. Luoyang's PL-12 active-guided BVR AAM has a range estimated to approach 100km, which may exceed that of the Russian Vympel R-77 and that of early versions of the Raytheon AIM-120 AMRAAM. In many scenarios this could give the FC-1 the crucial "first shot" that could determine the air engagement outcome. The FC-1 recently began flight tests with two 200km range YJ-83K anti-ship cruise missiles, and has also been seen flying with the Luoyang LS-6 satellite-guided glide bomb. Chinese companies Luoyang and CASIC produce two families of laser and satellite-guided bombs, to include very small satellite guided bombs, allowing the FC-1 to conduct precision strikes like modern Western fighters.



Chengdu FC-1 seen with the C-802AK attack missile, the SD-10A AAM and the LS-6 navsat-guided glide bomb at the 2011 Dubai Airshow (top). In November 2011 the FC-1 was seen over Chengdu flying with YJ-83K anti-ship missile shapes to validate their aerodynamic compatibility.

Source: RD Fisher and Chinese Internet.



**Price.** Perhaps the main reason that many non-traditional Chinese customers may consider the FC-1 is its bargain price. The FC-1 is most often said to cost \$15 to \$25 million per plane, which compares to \$70+ million for a late model F-16 Block 52. Such price quotes are not definitive as it is not known if they reflect unit cost or program costs (spare parts, weapons and training). In addition to already mentioned aspects, the FC-1's cost has also benefited from an efficient test program that included only four prototype aircraft and Pakistan's willingness to have early service JF-17s as part of an extended test program. Due to self-contained diagnostic equipment, many FC-1 components require only "as needed" maintenance, which can also reduce life-cycle cost.

Perhaps the FC-1's main price-range competition would be used F-16s. A 2009 sale of upgraded Dutch F-16s to Chile came to about \$15 million per plane,<sup>8</sup> whereas a 2010 U.S. F-16 sale to Romania came to about \$30 million per plane.<sup>9</sup> But the FC-1 will be a new fighter with up to date electronics, cockpit systems and weapons, plus a 4,000 hour service life ahead of it. The used F-16 may require expensive electronics and weapons upgrades to become competitive and its airframe may require extensive overhauling in order to extend its remaining service life hours.



The used F-16, however, would offer a commanding advantage in terms of logistics. Over 4,450 F-16s have been built for 26 air forces around the world. A recent U.S. Air Force decision to pursue a \$9.4 million apiece upgrade for 300 late model F-16s may extend their service life to 2030.<sup>10</sup> This means that the U.S. Air Force can remain a logistic and training “anchor” available to other air forces operating F-16s — a very important sales advantage. So far the PLA has resisted becoming a similar anchor customer for the FC-1, despite much urging by Pakistan and Chengdu. However, this could change once the FC-1 gains a proven Chinese-made engine and receives additional upgrades. While Pakistan may purchase a large number JF-17s and thus be able to offer effective logistical support, the fragility of Pakistan’s politics may prompt a preference for such support from China.

There are other competitors in this weight class. The most viable is the 13-ton SAAB Grippen canard single-engine multi role fighter, which has scored export success with Czechoslovakia, Hungary, South Africa, Switzerland and Thailand. Though a capable platform, the Grippen is also quite expensive with price estimates ranging from \$80 to \$100 million per plane. Another potential competitor would be the 13-ton Hindustan Aeronautics Limited (HAL) *Tejas* Light Combat Aircraft, though it may require more development before it can be exported. One price estimate held the *Tejas* might cost about \$30 million per plane, but a recent decision to upgrade the *Tejas Mk 2* to the more powerful General Electric F414-GE-INS6 turbofan may increase its cost. The Mikoyan MiG-29 is another 20-ton fighter that sold at about \$30 million apiece to Myanmar in 2009.<sup>11</sup> However, declining orders for the MiG-29 have raised questions about the future survival of this company.



During the November 2001 Dubai Airshow, Chengdu Aircraft Co. Chief Designer Yang Wei explained that an early planned upgrade for the FC-1 will be the addition of an aerial refueling probe.

Source: Chengdu Aircraft Co. via RD Fisher

**Upgrades.** At the November 2011 Dubai Airshow, Pakistani and Chinese briefers outlined suggested upgrades for the FC-1/JF-17. An initial “Block 2” version could have upgraded avionics, better weapons and a new aerial refueling probe. It is less clear whether Block 2 will feature a new radar, perhaps a smaller version of the new NRIET active electronically scanned array (ASEA) radar that equips the Chengdu J-10B fighter. But this may be used by a later Block, and by this time a Chinese-made engine would

likely be available. There are suggestions that Guizhou may be developing an improved 10-ton thrust version of its engine for the FC-1. It is not clear that an axisymmetric thrust vectoring system would be consistent with the FC-1's design priority to limit cost, but it remains an option that would improve maneuverability and take-off performance. The advent of India's *Tejas Mk 2* could prompt Pakistan to consider a better engine for future Blocks of the JF-17. A Pakistani briefer suggested that a twin-seat version of the FC-1/JF-17 could emerge by 2013-2014.<sup>12</sup> This would allow FC-1 to have a conversion trainer that could also be included in FC-1 units to reduce the usage of single seat fighters, extending their service lives. In 2004 a Pakistani official suggested that a twin-seat FC-1 could also be developed into a dedicated attack version.<sup>13</sup>

**Force Multipliers.** While many countries could opt to purchase only FC-1 fighters, there are many force multipliers available from China to increase their overall capability. Firstly, the FC-1 will be supported by China's future 30+ *Compass* navigation satellite constellation, expected to be in place later this decade. *Compass* will provide precision navigation and targeting for the FC-1 and its weapons in the event that the U.S. or Russia decide to degrade or deny signals from their respective Global Positioning Satellite and GLONASS navsat constellations. FC-1 customers would likely also be able to access imagery from the PLA's growing network of optical and radar surveillance satellites also to assist targeting -- or, as has Venezuela, opt to purchase their own Chinese surveillance satellite. China can also offer two low-cost airborne warning and control system (AWACS) aircraft, the KJ-200 with a linear phased array radar, and the ZDK-03, which uses a rotating saucer radar array. Both are based on modified Shaanxi Y-8 four-engine turboprop aircraft.



Pakistan has recently taken delivery of the first of up to three ZDK-03 AWACS, intended to compliment its fleet of JF-17 fighters. Source: Chinese Internet

## Developing the Latin American Market

One non-traditional market that China has decided will be a priority for future arms exports is Latin America. While, to date, its export success has been much less than that of U.S., Russian and European arms exporters, China's participation in regional arms exhibits has increased markedly in the last decade, and China has proven that it is not deterred from using arms exports to deepen its developing strategic relationships in Latin America. During the May 2011 SITDEF arms exhibit in Peru, Chinese companies were marketing new highly accurate short-range ballistic missiles. Perhaps its most strategic "project" in Latin America has been to strengthen its overall relations with the Bolivarian Alliance, a leftist and anti-American coalition most vocally led by Venezuelan autocrat Hugo Chavez, in close cooperation with Cuba, Bolivia and Ecuador. The last decade has seen China rapidly deepen its economic and political relations with this grouping to the point that such support is now a critical contribution to the viability of these leftist regimes.



At Peru's May 2011 SITDEF arms exhibition, Chinese arms exporter CPMIEC was marketing the SY400 and the B-611M short-range ballistic missiles.

Though China has limited its military relations with Cuba to deep intelligence cooperation and active military diplomacy, the strength and confidence in its relations with Venezuela and Bolivia have led to a gradual increase in arms sales. Both have purchased China's Hongdu K-8 jet trainer and light attack aircraft. Simple and inexpensive, the K-8 can be equipped with cannon and light bombs to attack insurgent and narco threats. Both have also purchased Chinese long-range and mobile radar systems. While only a modest increase in capability, these exports are important because they give China the opportunity to build regional confidence in its weapons and logistic support, easing its ability to promote follow-on sales. Sale of the FC-1 might prove an attractive option for both Venezuela and Bolivia to acquire an impressive but inexpensive capability that also builds on their investment in the K-8. In November 2011 there were

Chinese internet rumors that a delegation from Venezuela was visiting the Chengdu fighter factory at the same time the FC-1 was making initial test flights with the YJ-83K anti-ship cruise missile.

If true, such a report would be consistent with other reports of Venezuelan interest in new Chinese fighters. Even though Venezuela chose to purchase Russian Sukhoi Su-30MKV fighters in 2008, it remains possible that it could pursue interest in the FC-1 and J-10, especially after they become proven with an indigenous Chinese engine. If it decides to do so, it would also be consistent for Venezuela to purchase a range of modern weapons to equip its new fighter, as well as to consider the purchase of AWACS and modern 4<sup>th</sup> generation SAMs to complete an air defense network. Ultimately, however, China's ability to develop deeper military relationships will help to facilitate a more frequent formal Chinese military presence. In October 2011 the PLA used the second diplomatic excursion of its new hospital ship, called "Mission Harmony 2011," to visit Cuba and other states in the Caribbean. While in Cuba the hospital ship was used to highlight the visit of PLA Central Military Commission Vice Chairman General Guo Boxiong. It is not beyond consideration that within this decade, should military ties with Cuba and Venezuela deepen further, PLA aircraft carrier battle groups could be making port calls.



In late October 2011 the PLA hospital ship *Peace Pearl* visited Cuba's Havana harbor, in time to highlight a visit by PLA CMC Vice Chairman General Guo Boxiong. Cuban leader Raul Castro was also in this audience aboard the PLA ship.

Source: CCTV

## Conclusion

China has built an impressive ability to export effective and inexpensive weapons, exemplified by the Chengdu FC-1 lightweight fighter. China is also willing to use the sales of such new weapons to complement its gathering economic and political power where it so desires. One such region now a priority for arms sales promotion is Latin America. In the Bolivarian group China has established a political-economic beachhead that it is now seeking to turn into a strategic asset with deeper military relationships, such as with Venezuela. Initial military sales of radar and jet trainers are intended to prepare the way for the sale of more sophisticated weapons like the FC-1 and perhaps 4<sup>th</sup> generation SAMs. Such an assemblage would most troublesome to most existing U.S. 4<sup>th</sup> generation fighters, U.S. Air Force F-15s and F-16s, and U.S. Navy F-18C fighters not

equipped with AESA radar. The U.S. would face greater pressure to keep available its limited number of superior F-22A stealth fighters, and later its newer F-35 fighters, in order to meet potential regional challenges.



To meet a U.S. Air Force requirement to replace the T-38C supersonic trainer, Lockheed-Martin proposes a version of the T-50 trainer (left) while Boeing unveiled a new V-tail concept in late 2011. Both could form the basis for a new inexpensive lightweight fighter. Source: RD Fisher

While the potential for China to build deeper military influence in Latin America serves to undermine Administration hopes that it can reduce America's defense posture from preparing to fight two simultaneous conflicts, to just one war and a spoiling action, it also points to a growing requirement for the U.S. to blunt China's military trajectory into the Western Hemisphere. But Washington may not get results simply by warning Latin friends about the dangers of Chinese strategic penetration at a time when China's commercial and economic appeal is growing. It will also be necessary for Washington to offer positive incentives, which could include promoting the development of cost efficient systems that can compete with Chinese military sales even in terms of price.



Though designed to meet a late 1970s requirement, the Northrop F-20 lightweight fighter also could form the basis for a new supersonic trainer/lightweight fighter to compete with the Chengdu FC-1.

For example, a U.S. Air Force program to develop a successor to the venerable Northrop T-38C supersonic jet trainer could be configured to allow U.S. companies to develop a new lightweight fighter that can exceed the Chengdu FC-1 in terms of performance and value. U.S. fighters companies do not lack for candidates. To meet the current U.S. Air Force requirement Lockheed-Martin is offering a version of the Korean Aircraft Industries T-50 jet trainer while Boeing recently revealed its concept for a T-38 successor. Northrop-Grumman could revive a version of its F-20 fighter, developed in the late 1970s to meet an earlier Carter Administration program to develop a dedicated export fighter. With lightweight AESA radar designs offered by Raytheon and Northrop-Grumman, these designs could form the basis for a new very capable and inexpensive 11-13-ton supersonic fighter. A key U.S. advantage would be the General Electric F414 EPE engine, which promises an amazing thrust -- 26,400lb (11.9-tons) -- for its small size, potentially giving the U.S. fighter excess energy for superior acceleration and maneuverability. Such an aircraft could also serve as a less expensive to operate lead-in trainer for U.S. 5<sup>th</sup> generation fighters.

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<sup>1</sup>“ Bolivia buys more arms to fight drug traffickers,” *UPI International*, February 9, 2011, [http://www.upi.com/Business\\_News/Security-Industry/2011/02/09/Bolivia-buys-more-arms-to-fight-drug-traffickers/UPI-97611297290490/](http://www.upi.com/Business_News/Security-Industry/2011/02/09/Bolivia-buys-more-arms-to-fight-drug-traffickers/UPI-97611297290490/)

<sup>2</sup> Grumman’s participation reportedly started in 1984, but one source notes the Sabre-II program may have started as a Pakistan-China effort in 1974, see, Ghazi Shah, “JF-17 Thunder dawn of a new era,” *Aerospace International*, August, 2010, p. 13.

<sup>3</sup> For an excellent overview of the JF-17 in Pakistan service, see Alan Warnes, “JF-17, Thunder from the East,” *Air Forces Magazine Supplement*, June 2011.

<sup>4</sup> “KLJ-7 Airborne Radar,” *Pakistan Aeronautical Complex Kamara Web Page*, Accessed January 26, 2012, [http://pac.org.pk/elec\\_KLJ7.html](http://pac.org.pk/elec_KLJ7.html)

<sup>5</sup> Author interview, 2009 Dubai Airshow. For much of the last decade Chinese companies have been developing a Helmet Mounted Display, which like the Helmet Mounted Sight, can target off-boresight AAMs, but also provides the pilot with much more flight and radar data on a helmet visor, so that he does not have to divide his attention between following cockpit displays and following the fight.

<sup>6</sup> Siva Govindasamy, “Farnborough: Pakistan and China eye JF-17 export customers,” *Flight International*, July 19, 2010, <http://www.flightglobal.com/news/articles/farnborough-pakistan-and-china-eye-export-jf-17-customers-344624/>

<sup>7</sup> Author interview, November 2011 Dubai Airshow.

<sup>8</sup> “Chile to finalize F-16 Deal with the Netherlands,” April 30, 2009, <http://www.armybase.us/2009/04/chile-to-finalize-f-16-deal-with-netherlands/>

<sup>9</sup> Gerard O’Dwyer, “SAAB Offers Grippens At Used F-16 Prices,” *Defense News*, April 26, 2010.

<sup>10</sup> Graham Warwick, “USAF To Extend F-16s To Cover F-35 Delays,” *Aviation Week and Space Technology*, November 9, 2011.

<sup>11</sup> Sergey Balmasov, “Russian Mig-29 Jets ‘Attack’ China in Myanmar,” *Pravda*, December 24, 2009, <http://english.pravda.ru/world/asia/24-12-2009/111368-mig29-0/>

<sup>12</sup> Author interview, November 2011 Dubai Airshow. Though Pakistani officials have been commenting on a two-seat JF-17 version since 2004, one reason given for the delay in its emergence is that Pakistan may be waiting for the Chinese side to fund its development.

<sup>13</sup> Author interview, October 2004 IDEAS arms show, Karachi, Pakistan.