

# Air superiority 'Game Changers': T-50 PAK-FA and J-20

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The emergence of non-United States stealth fighters is a pivotal strategic development, but one which has also been long expected, given that the first US stealth fighter, the F-117A Nighthawk entered production thirty years ago. In the intervening period the Soviet Union collapsed and China industrialised on a large scale. The notion that the United States could hold this technological and strategic advantage indefinitely was never realistic, as appealing as this idea may have been in United States policy circles.



*Sukhoi image of T-50 PAK FA prototype.*

The seeming lack of interest in these developments by the United States Office of the Secretary of Defense during the tenure of Robert M. Gates - to the extent of ignoring the Russian PAK-FA and later denigrating the Chinese J-20 - will rank in history as a blunder on the scale of the unquestioning belief in the Maginot Line and 'invincible' Battleships during the period preceding the Second World War.

The absolute strategic failure of this doctrine is evident, with the recent United States reversal of strategic doctrine and defence policy. Unfortunately, enormous damage was done in the meantime, with the termination of funding for further F-22A Raptor production. The United States and its many allies will have just over 130 'combat coded' F-22A Raptors available to strategically balance the planned Russian PAK-FA build of ~1,000 aircraft for Russian and export customers, and some yet to be determined number of Chinese J-20s to be operated by the PLA-AF, PLA-NAF and Chinese client states.

While the F-22A is stealthier than the PAK-FA and J-20 prototype configuration, both foreign fighters are expected to outperform the F-22A aerodynamically. This has important implications for the character of future air combat.

The F-22A Raptor was built to fight supersonic, with supercruise engines to provide unprecedented supersonic persistence, and excellent all-aspect stealth, to deny the opponent both warning of an impending attack and to degrade the opponent's weapon seeker performance should close combat be necessary. The F-22A tactic is to 'stalk' its victims silently, position for an attack, and ambush them with a Beyond Visual Range missile shot. If that failed, the F-22A would close in and kill

the opponent in close combat, possessing vastly better energy manoeuvre performance than any Cold War era fighter of Western or non-Western origin. In a world equipped with non-stealthy and non-supercruising opponents, the F-22A would and indeed does rule supreme.

The advent of the PAK-FA and J-20 changes this strategic imbalance in fundamental ways.

Because both the PAK-FA and J-20 will have respectable stealth performance, especially head-on in the centimetric X-band used by fighter radars, the F-22A will often be denied opportunities to initiate a Beyond Visual Range missile shot; radar physics apply and sensor range will be the limiting factor, rather than missile kinematic range. The F-22 will have to close much nearer to a PAK-FA or J-20 to effect a missile shot, compared to any legacy target.

Without the advantage of shooting at very long ranges, this drives the F-22A into the acquisition and tracking envelope of opposing InfraRed Search/Track sensors, employed on the PAK-FA, and expected on the J-20. In turn, this means the opposing player also gains an opportunity to acquire and shoot. The advantage held by the F-22A is thus considerably reduced.

Because the PAK-FA and J-20 are also supercruising designs built to fight supersonic like the F-22A, and also highly agile in close combat, the F-22A has no compelling advantage over either foreign fighter in a 'knife-fight'. The better radar and infrared stealth design of the F-22A will seriously impact the lethality of the missiles carried by the PAK-FA and J-20, but the converse is also true - the AIM-120 is challenged in manoeuvre performance against high-G targets, while the AIM-9X is challenged in energy performance, using a legacy rocket motor.

As all of these aircraft are supercruisers, none can easily disengage and outrun its opponent, once close combat has been entered. Future stealth, sensor and missile upgrades to the F-22A will provide an incremental advantage over its foreign rivals, but never on the scale of the advantage enjoyed against non-stealthy non-supercruising legacy fighters like the Flanker, Fulcrum, Typhoon and Rafale.

In practical terms, even if the F-22 can be kept ahead of the PAK-FA and J-20 by progressive upgrades leading upgrades to the foreign types, maintaining at least parity will mean matching PAK-FA or J-20 numbers with F-22A numbers in any given theatre of operations. That is the only viable strategic choice for the United States and its allies. The acquisition of wide area counter-stealth sensors is not enough, given the prodigious supersonic performance of this class of fighter aircraft - the United States has no active counter-stealth development programs.

The 'Gates Doctrine' was predicated on the idea that the F-35 Joint Strike Fighter would be competitive one-on-one against the PAK-FA and J-20, as committed build numbers long term for the F-35A were of a similar size to the planned number of PAK-FAs, plus some hundreds of J-20s. This belief remains firmly shared by Defence in Canberra.

Given that the PAK-FA and J-20 can outperform aerodynamically all F-35 variants in all flight regimes, and will have at least comparable stealth and sensor performance, while carrying more missiles and more fuel, the steadfast belief in the superiority of the F-35 over the PAK-FA and J-20 remains to be explained, in the United States and in Australia.

What is clear is that the present situation is at best a serious miscalculation borne from a failure to study and understand technological growth in Russia and China, and at worst an abrogation of responsibility for the future strategic position of the West.

## SUKHOI/KNAAPO T-50 PAK-FA PROGRAM DEVELOPMENTS

The flight test effort in the T-50 development program has continued at a rapid pace. The most recent public statements from Russia are indicative.

Russian Air Force Commander Colonel General Alexander Zelin in an interview with RIA Novosti in early February stated that "There are three fighters already in tests, another three are expected to be tested in the nearest future. The entire number of aircraft planned for test flights is 14," later said to be by 2015. This indicates that the Initial Operational Capability (IOC) targets of around 2013 are likely to be met, since latter test aircraft are typically employed for expanding weapons clearances, especially in air to ground munitions. Russian media reports indicate that weapons clearances are to commence in 2013.

Mikhail Pogoyan, the head of the United Aircraft Corporation (UAC), which owns Sukhoi and KnAAPO, in an early-February media interview stated that deliveries of the Low Rate Initial Production batch of T-50 aircraft would commence in 2013, and that the third PAK-FA prototype had already logged 120 test flights, following the first two prototypes.

Zelin also observed that "After a comparative analysis of the fighter's characteristics with the U.S. F-22 Raptor and Chinese J-20 stealth aircraft, we can conclude that PAK-FA exceeds the foreign analogues in maximum speed, combat radius, maximum takeoff weight and the maximum load factor value". These claims are entirely consistent with independent Western analytical assessments of the PAK-FA's aerodynamic, control and propulsion design, compared to the F-22A Raptor. Over the last year there have been other interesting disclosures on the PAK-FA program.

The first are persistent claims that a rectangular stealthy thrust vectoring exhaust nozzle similar to

that on the F-22A is in design for the aircraft, to be mated with the intended Fifth Generation Fighter Engine currently in development for production PAK-FA aircraft. Initial analysis of the prototypes identified stealth shaping inconsistencies in the aft fuselage, suggesting that the AL-41FA / 117S engines with three dimensional thrust vectoring were indeed a temporary measure to expedite flight testing. This is important as the convergent-divergent axi-symmetric exhaust nozzles on the prototype PAK-FAs are a serious problem for aft sector stealth, effectively ruining the otherwise sound shaping design. A faceted and blended nozzle design modelled on the F-22A would make the PAK-FA much more difficult to detect and engage from the aft hemisphere.

The radar system for the PAK-FA will be based on AESA technology, with three X-band arrays, and two L-band arrays. The X-band configuration would appear to be modelled on the initial F-22A scheme with a nose array and paired side-looking cheek arrays, the latter deferred to save money in the F-22A program. The L-band arrays will provide a limited forward looking counter-stealth capability, while providing also IFF and jamming capabilities. Initially intended missiles are to be the RVV-MD, a derivative of the R-73/73 / AA-11 Archer, and the RVV-SD, a derivative of the R-77 / RVV-AE / AA-12 Adder or "Amraamski".

## CHENGDU J-20 PROGRAM DEVELOPMENTS

While Russia's PAK-FA program has brought frequent media interviews, display flights of prototypes, and public lobbying by prime and subcontractors, official and other disclosures on the Chengdu J-20 have been scarce and often vague. While many amateur and some official photographs are widely available, many are of especially poor quality, hampering technical analysis.

The result has been what could be described as an orgy of speculation in Western analytical circles, much of it playing to media or political audience expectations, which in the US depend wholly on which side of the political 'Obama divide' the media outlet caters for. This is unfortunate since the results are more than often nonsensical and intended to yield political embarrassment rather than actual insight. Especially curious has been

the use of the J-20 as an argument for increasing F-35 buys, put forth by at least two known F-35 advocates.

The most recent photoessay published by the official Xinhua news bureau claims that the 53rd test flight of the first prototype was flown in early December, 2011. Given that many Western analysts suspect the prototype flew well before the public debut during Robert M. Gates' visit to China over a year ago, this number may or may not be accurate. The accompanying poor quality images suggested low level flight at 20 degrees alpha over the airfield.

Other imagery shows the weapon bay arrangement, modelled on the F-22A, with 'cheek' bays for short range missiles, and tandem ventral fuselage bays for larger missiles and bombs.

The only major English language study dealing with the PAK-FA published in 2011 was authored by Dr Michael Pelosi and this author, and was a large monograph covering the results of an extensive effort to perform computer modelling of the stealth performance of the J-20 (HYPERLINK "<http://www.ausairpower.net/APA-2011-03.html>"<http://www.ausairpower.net/APA-2011-03.html>).

The software modelling, performed using an adaptation of an unclassified US Navy modelling tool, validated earlier visual observations of the basic stealth behaviour of the design. Modelling was performed for nine key radar bands, from all aspects, with and without a radar absorbent skin.

The use of F-22A stealth shaping design rules is prominent and shows that of the F-35, PAK-FA and J-20, only the latter has potential to compete with the F-22A in observables performance. The slab sides and flat lower fuselage yield significantly better all aspect stealth performance to the F-35 and PAK-FA, both compromised badly by lower fuselage design. Key weaknesses in the J-20 stealth design include curvatures in the slab sides, aft strakes, and the use of axi-symmetric nozzles in common with the F-35 and prototype PAK-FA. The result of these problem areas is that J-20 stealth shaping remains inferior to the F-22A, but is still superior to the F-35 and PAK-FA.

There have been no official or quasi-official disclosures to date on the intended weapon types or sensor fit for the J-20.



Aft view of the J-20. The axi-symmetric nozzles are the single greatest weakness of this otherwise robust stealth shaping design.



The side weapon bay doors are modelled on the F-22A arrangement, but use a less sophisticated door design.



Detail of J-20 nose and inlet. The main weapon bay doors are discernable.