F/A-22As, JSFs and 21st Century air combat

By Dr Carlo Kopp

"The F/A-22 will be the most outstanding fighter aircraft ever built. …Every fighter pilot in the Air Force would dearly love to fly it." *Air Marshal Angus Houston, August, 2004*

In the August issue of Australian Defence Magazine, NACC Director General, Air Commodore John Harvey, discussed the JSF in the context of the networked Air Force. Timed to coincide with the ASPI JSF paper, this unprecedented incursion into the trade press raises many more questions than answers.

The article starts with a lead in claiming "Air combat in the 21st century is all about systems and networks of systems - the old rules of thumb about what gives you a winning edge are obsolete'. This is a very bold claim as it elevates information and sensors above aircraft aerodynamic performance, but also implicitly assumes an asymmetric advantage in information gathering and distribution means.

The hard reality is that kinematics has always mattered in air combat, and always will matter. No amount of information or networking can make a fighter which is significantly slower, and less persistent at high speeds, consistently prevail over an aerodynamically superior opponent, especially if that opponent is also fed by an AEW&C aircraft via networking. If the "networking beats kinematics" argument were to be true, then the F/A-22A program would not exist.

Of no less concern is the implicit assumption of a persistent long term asymmetric advantage in information gathering and distribution capability on the part of the JSF supported by the Wedgetail and MIDS/JTIDS/Link-16 datalinking. AEW&C aircraft have been ordered by India, China is test flying a demonstrator, and Malaysia has them on its shopping list. By 2020 nations without AEW&C will be the exception in the region, rather than the rule. No less importantly, the Russians have actively marketed the APD-518 and TKS-2 datalinks on their Sukhoi fighters – the latter capable of networking up to sixteen fighters. JTIDS/Link-16 is evolved 1970s technology and the expectation that similar capabilities are unavailable to the region in the 2020 timescale is completely unrealistic.

No differently, the assumption that AEW&C aircraft and networks can operate unchallenged in the region over the longer term is also completely unrealistic.

India and Russia are currently negotiating joint development and production of the Novator R-172 (formerly KS-172) RVV-L"AWACS Killer" missile, built to destroy AEW&C, JSTARS, RC-135V/W and tanker aircraft at ranges up to 215 nautical miles. Variants of the existing ramjet powered Kh-31 series with similar applications have been acquired by China. There has also been ongoing discussion about the integration of the R-33/R-37 (AA-9 Amos) family of long range missiles on the Sukhoi fighters, while development of the 100 nautical mile class ramjet Vympel R-77M missile continues. By 2020 there will be a menagerie of long range missiles in the region, many specifically designed to kill AEW&C aircraft, and some apt to be licence built by larger regional operators.

Concurrently the Russians have been continuing with the development of high power jamming technology which can be used to blind AEW&C and GCI radars, but also disrupt networks. Defensive jamming pods using Digital RF Memory, the technology at the core of latest Western jamming equipment, are being marketed by the Russians. Reports are also emerging of the development of a support jamming aircraft, based most likely on the Su-32 Fullback airframe, and built to occupy the niche of the EA-6B Prowler and EA-18G Growler. The Soviets operated support jamming variants of the Tu-16 Badger during the Cold War, and a basic Prowler/Growler equivalent is well within reach of current Russian technology – and regional budgets.

In practical terms the region of 2020 will be characterised by the wide use of technologies designed to deny the gathering and distribution of information, operated in parallel with AEW&C aircraft and digital networks. There will be no asymmetric advantage favouring the RAAF, at best an incremental advantage in technology.

The *ADM* article quickly moves to dismiss the F/A-22A as an alternative to the JSF, claiming incorrectly "that it is still unclear whether it will provide a true multi-role capability and at approximately US$150 million it is simply unaffordable". One hundred F/A-22s would lead to a total project cost at least three times the budget currently available with no guarantee of a robust strike capability'. This fallacy continues the trend established in the ASPI paper, which makes much the same claims.

The reality is that advanced strike capabilities in the F/A-22A have been budgeted for and IOCs committed. Next year's production F/A-22As will carry the GBU-32 JDAM and by 2007 the F/A-22A will be equipped to carry 8 internal GBU-39/B Small Diameter Bombs, the same basic payload as the JSF does. The F/A-22A's APG-77 radar will have a high resolution Synthetic Aperture Radar capability for precision all weather strike – within the existing budget, and a JTIDS transmit capability. By 2012 production F/A-22As are expected to carry satellite terminals for global connectivity. Many other smart munitions and sensor enhancements are planned for, providing mostly identical strike capabilities to the JSF.

The cost comparisons presented between the JSF and F/A-22A are no less erroneous, and amount to an "apples vs oranges" asymmetric comparison of average early build F/A-22A costs against mature JSF flyaway costs – effectively comparing worst case near term F/A-22A pricing against long term best case JSF pricing. Considering the flyaway costs of the F/A-22A in the timescale of interest around 2012, the number is closer to US$85 million, making the current NACC budget large enough to buy of the order of 70 F/A-22A aircraft. In raw bang for buck terms, seventy twin engine supercruising F/A-22As provide more capability and

flexibility than 100 single engine JSFs do.

The *ADM* article then argues that stealth is "one of the features that discriminates it [the JSF] from its competitors", neglecting to mention that the principal competitor to the JSF, the F/A-22A, is actually built for significantly higher stealth capability than the JSF will have. While the JSF will be much stealthier than evolved third generation fighters and opposing Sukhois, its stealth shaping has been optimised for the upper X-band and forward hemisphere, a viable design choice for a battlefield strike fighter, but not for an air superiority and deep strike fighter. This is a large departure from the F/A-22A which is built to provide high stealth in all sectors, and over a wider range of opposing radar wavelengths. The *ADM* article fails to explain that export JSFs will have further reductions in stealth performance, relative to the US baseline, itself that much inferior to the F/A-22A.

No mention is made of the F/A-22A's supersonic cruise capability, totally absent in the JSF due to its transonic performance optimised wing and engine design. Supersonic cruise allows the F/A-22A to remain at supersonic speeds without using afterburner – the performance envelope of the F/A-22A in dry thrust is designed to cover the performance envelope of the F-15 in afterburner. To put this in context, the

JSF is designed to fit the performance envelope of the F-16 and F/A-18, both inferior to the F-15 series and the Sukhois the JSF will have to defeat.

With supersonic cruise, an F/A-22A can persist at supersonic speed, retaining an altitude and speed advantage throughout an engagement, yet it also puts the F/A-22A outside the kinematic envelop of all but the largest Surface to Air Missiles. Moreover, by supercruising between aerial refuellings, an F/A-22A can transit long distances at almost twice the subsonic cruise speed of conventional fighters like the

JSF and teen series. Where large distances matter, the F/A-22A can be twice as productive as a JSF due to cruise speed alone.

An issue in its own right is the inevitable emergence of supercruise in the Russian technology base, as the AL-41F series engine matures. We should not be surprised to see a supercruising Flanker variant in the region before the end of the decade. With a performance envelope competitive against the F/A-22A, the JSF would have little chance of successfully engaging such an aircraft, or indeed evading it.

The remaining content in the *ADM* article mostly comprises a description of the JSF's planned avionic suite and weapons capabilities.

The discussion of the JSF's APG-81/MIRFS multimode AESA radar amounts to a flat summary of design features and capabilities, and makes no effort to compare the radar's capabilities against other AESA designs such as the APG-77 in the F/A-22A, the APG-79 in the F/A-18E/F, the APG-80 in the F-16E/F, the AMSAR in the EF2K and Phazotron's new AESA planned for the Su-30 series.

The important distinction is between the F/A-22A and JSF radars, as the former has much higher power-aperture performance using the same generation TR module technology – the F/A-22A radar covers around twice the area footprint of the JSF

radar, and will provide greater standoff range and jam resistance in hostile environments.

What the *ADM* article fails to explain is that detection range in GMTI modes against moving ground targets strongly depends on radar power rating, where the F/A-22A's APG-77 is well ahead of the JSF's APG-81. It also fails to explain that high resolution in SAR ground mapping modes is bounded by the coherency of the radar master oscillator, accuracy of platform motion measurement, and bandwidth of the receiver channel – any modern AESA can thus acquire such a capability.

Perhaps the most unusual observation in the *ADM* article is the claim that ”the JSF will therefore provide the networked RAAF with a capability similar to the US JSTARS”, comparing the APG-81 radar in the JSF to the APY-3 in the Boeing 707 based E-8C JSTARS. This is equivalent to claiming that a fighter air-intercept radar provides a similar capability to an AEW&C/AWACS radar, simply because it can detect the same class of targets. Evidently radar power-aperture rating doesn't quite count here!

The JSF's APG-81 radar is also presented as suitable for cruise missile defence, a curious argument insofar as the US Air Force intend to use the F/A-22A/APG-77 system for this role primarily. Hunting cruise missiles demands high power ratings, and the F/A-22A is much more suitable for the role, especially if supersonic cruise missiles are the threat. No mention is made of the impact of supersonic cruise on the cruise missile interception role, perhaps not surprising as the JSF lacks this basic F/A-22A capability.

No less curious is the one line argument presenting the utility of the JSF's APG-81 in the Electronic Attack role, used as a high power jammer. This capability is expected to be exploited in all US AESA radars, but is limited to X-band threats which are close in wavelength to the X-band operating frequency of the radar. Most threat radars of interest operate well outside the frequency range of X-band AESA radars, and the APG-81 is no exception.

The argument presented that the APG-81 provides an inherent reconnaissance capability is valid, but fails to point out that this is true of all of its contemporaries, and requires a high capacity and high speed internal data storage subsystem to properly exploit. This is another capability not unique to the JSF.

The JSF's Electro-Optical Targeting System (EOTS) receives considerable attention in the *ADM* article. This system is a repackaged, internally carried and improved derivative of the podded Sniper XR FLIR/laser targeting system now being fitted to the F-15E and F-16C in the US. While a good example of current production FLIR targeting technology, it is not a system which pushes the technology envelope either in aperture size or band coverage.

The *ADM* article discusses the Distributed Aperture System (DAS), which is perhaps the only sensor system currently unique to the JSF. What is not explained is that the DAS was designed for lower altitude close air support and battlefield interdiction operations, and incurs a weight/cost/complexity penalty which may not yield a large return in other roles.

The radar warning and passive targeting capabilities in the JSF are presented, but without comparisons to other systems, especially the more capable package in the F/A-22A. In this context there is no discussion of current US planning to add low band defensive jamming capability on the JSF, a *de facto* admission that the limited stealth performance of the aircraft is being overtaken by newer Russian technologies.

Data fusion and networking capabilities are summarised in the *ADM* article, again without comparisons, especially against the capabilities in the F/A-22A. While these are very important advancements, they are not unique to the JSF and should not be presented as such.

In summary, the ADM article follows the now well established approach in recent air force generated publications of avoiding all direct comparisons of JSF sensors and systems against the established technology base, and especially against the F/A-22A, and extensive Australian industry upgrade proposals for sensor enhancements to the F-111 . Unfamiliar readers are thus presented with a carefully crafted snapshot of reality without any bases for comparisons. What is perhaps of most concern is that most of the avionics capabilities in the JSF are not unique, and are or will be available as retrofit options on other aircraft, including legacy types.

The latter portion of the *ADM* article explores the JSF as a "shooter", discussing planned weapons capabilities.

This discussion starts with the curious claim that the JSF with 10 weapons stations, can actually carry more weapons than the F-111". This claim is curious because the F-111 has around twice the total weapons payload capability of the JSF, to a significantly greater combat radius, or with much greater persistence on station. The JSF has two internal stations and four external stations rated for 2,000 lb class weapons, with two internal stations for air-air missiles, two outboard wing stations for air-air missiles, and a centreline station for a 1,000 lb store. The design payload is a pair of internal 2,000 lb weapons, higher payloads compromising both stealth and combat radius performance. The F-111 has four pivot pylons rated for 3,000 lb or heavier weapons (the 4,700 lb GBU-28 was carried by F-111Fs), with a pair of internal bomb bay stations used to carry the 2,500 lb class SRAM missile in US

FB-111As, and two auxiliary stations for air-air missiles. With four 2,000 lb weapons the F-111 provides a combat radius around 40% greater than a JSF with two internal 2,000 lb weapons. Fitted with smart Mil-Std-1760C ejector racks the F-111 could carry twice the payload of smart munitions the JSF could carry, and typically lifts 47% of the 500 lb bomb payload of a B-52H heavy bomber.

Yet again we observe an "apples vs oranges" comparison in which legacy F-111 smart munitions payloads are compared to future JSF payloads, with no attention paid to the vital issue of radius/persistence for a given payload, or to the Block C-4 Mil-Std-1760C capability now being introduced on the F-111. Suffice to say the list of

Mil-Std-1760 smart munitions for the JSF in the *ADM* article are all weapons which can be integrated on any Mil-Std-1760 capable system, including the Block C-4 F-111C.

The *ADM* paper briefly departs from discussing munitions to argue the case for using the AESA Electronic Attack capability, but fails to explore the limitations of an X-band centred design against the plethora of non-X-band threats across the region. Clearly there seems to be an expectation that regional players will migrate capabilities into the X-band so RAAF JSFs can jam them.

No less curious is that no mention is made of the Russian Vympel R-27P and R-77P/MP X-band anti-radiation missiles – variants of standard BVR missiles carried on the Sukhoi Su-27, Su-30 and Su-35 series fighters. Equipped with 9B-1032 series passive RF homing seekers rather than the standard active radar 9B-1103M / 9B-1348E or heat-seeking MK-80M seekers, these missiles would find a high power jamming waveform from the APG-81 to be more useful than a search/track waveform as a homing signal source.

Equally curious is that no mention is made of the X-band interferometers used on more recent Russian S-300 SAM system radars, the aim of these being precise angular measurement of X-band jamming sources to facilitate SAM guidance. Clearly an inbound Mach 6 class 9M83 SAM is not a consideration for JSF planning, despite regional exports of S-300 systems.

The final section in the *ADM* article is a discussion of Strike and Defensive Counter-Air scenarios using the JSF. Both are predicated on the assumption that the opponent is using legacy Soviet technology and tactics, rather than systems and technique now entering service or in late development.

The Strike scenario presented is a standard Battlefield Air Interdiction model as envisaged by the US Air Force for the JSF – long range radars and SAM systems are absent as these have been killed earlier by F/A-22As. The opponent is using a mobile point defence SAM system, operating without Integrated Air Defence System support or cueing by passive sensors.

The reality of regional strike operations will be different – high value targets defended by a mix of semi-mobile long range low band radars, and mobile long range area defence SAM systems such as the S-300PMU-2, S-400 and S-300VM, equipped with Aegis class high power phased arrays such as the 30N6E2, 64N6E2 and 9S32M. Passive detection systems will be used to supplement high power search radars.

With stealth and sensors optimised for Battlefield Air Interdiction, the JSF is intended in US Air Force operations to fly under the protective umbrella of F/A-22As which will destroy the upper tier air defence threats, airborne and surface based. The scenario presented in the *ADM* article is completely unrepresentative.

If we put an F/A-22A into a strike-recce scenario, we have an aircraft penetrating supersonic at 50,000 ft, with all aspect stealth capability, and similar or identical payloads of smart munitions. The F/A-22A will kinematically defeat most threats, yet its stealth and radar warning system will hide it from nearly all opposing systems. With a longer ranging radar and supercruise, the F/A-22A can perform radar terrain mapping at twice the rate of the JSF, in reconnaissance roles – an electro-optical recce sensor payload repeats this effect. The US Air Force aim to use the F/A-22A as an ”information gatherer” compared to the JSF, to be used mostly as an ”information consumer".

No differently, the Defensive Counter-Air scenario fails to explore the reality of a future regional environment with evolved Sukhoi fighters supported by AEW&C and support jamming aircraft, and equipped with a complex mix of long range missiles.

If we put an F/A-22A into this scenario, it kinematically defeats nearly all opponents, and with all aspect stealth and supercruise can engage and disengage at will. The

F/A-22A will have the capability to bypass defending CAPs and destroy opposing AEW&C aircraft and jamming platforms. Its large radar and capable passive detection system will allow it to operate autonomously with little or no support from an AEW&C aircraft, should the latter be threatened. The F/A-22A's supersonic cruise will allow it to intercept supersonic bombers and cruise missiles, a kinematic challenge for the JSF at the best of times.

The conclusions presented in the *ADM* article are inevitably unsupportable, as they are predicated on unsupportable assumptions. The unavoidable reality is that the JSF will be an excellent fit to its design role of Battlefield Air Interdiction, but a poor fit to the air combat and deep strike roles it will need to perform in RAAF service.

It is worth observing that the JSF will be a viable export fighter for the European market, simply because the post Cold War strategic reality for EU NATO members is the provision of supporting assets for US led coalition warfare campaigns. Australia's strategic circumstances are entirely different with the geographically unavoidable reality of a regional arms race in high technology weapons. A strike fighter designed to perform over the battlefield, defended by F/A-22As, is not a good choice for beating AEW&C supported Sukhoi variants and S-300 family SAM systems as a single type solution.

In summary, the ADM article continues the established pattern of unrealistic comparisons and factual errors observed in earlier air force sponsored documents.