This article was published originally in Australian Defence Magazine in February 2003 . Although over five years old it covers much of the background to the original decision by the Australian government to join the Joint Strike Fighter System development and demonstration (SDD) Phase and work towards acquiring the F-35A Lightning II. References in this article to prices, schedules and numbers of aircraft may have been overtaken by subsequent events. GF

Rumour Control
Joint Strike Fighter - a leap of faith for the RAAF

INTRO: The Federal government's decision to buy into the US$200 billion Joint Strike Fighter program is a huge leap of faith.

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Based on the guidance in the 2000 Defence White Paper the RAAF could buy as many as 100 F-35 Joint Strike Fighters to replace its 71 F/A-18 Hornet fighters and 35 F-111 strike aircraft from about 2012.

But the F-35 isn't even in production yet. Its detractors call it a 'paper plane', warning that it will probably be late, over-priced and not as stealthy and lethal as the Pentagon and prime contractor Lockheed Martin claim. Sweden's Saab Gripen, Boeing's Super Hornet, the French Dassault Rafale and multi-national Eurofighter Typhoon were all credible contenders for this contract under Project Air 6000 - Australia didn't need to choose a new fighter until 2006, so why the rush to join the F-35 program?

There seem to have been three principal reasons, all of them closely inter-locking: cost, capability and technology access.

Achieving a decisive combat edge has made combat aircraft more and more expensive. Today, even the US Air Force is acknowledging it can't afford to live on the 'bleeding edge' of aerospace technology and its major new tactical aircraft programs, the F-22 and F-35 are under unprecedented levels of political and budgetary scrutiny.

For Australia, a reduced air combat capability is not an option - successive White Papers and analyses have re-stated the critical importance of the RAAF's air combat capability to the core ADF mission of defending Australia. But the 2001 Defence Capability Plan puts a price tag, and a cost cap, on that capability.

"In terms of the alternatives that'll be around in the post-2012 era, we don't believe that there's any other alternative that would meet our capability requirements within the costings that we put into the White Paper," said the Minister for Defence, Senator Robert Hill, in June last year announcing the decision to invest in the JSF program..

On paper, the F-35 is a lot of aircraft for the money and five out of the nine launch customers - Australia, Canada, Denmark, Holland and Norway - plan to make it the only combat aircraft in the air force inventory. The USAF's F-35A Conventional Take-Off and Landing (CTOL) version that Australia will probably order should cost about US$37.3 million (AUD$67 million) each at today's prices.

The SDD phase of the program will run to 2012 and see the production of eight ground test articles and 14 flight test aircraft, all in full production configuration. The first to fly will be the USAF's CTOL variant in 2005, followed by the US Marine Corps' STOVL and then the US Navy's carrier borne (CV) variants in 2006. Two batches of Low-Rate Initial Production (LRIP) aircraft will be acquired from 2006 to 2009: 6 CTOL and 4 STOVL aircraft in the first batch and 14 CTO and 20 CV in the second.

With production deliveries due from 2008 (with the STOVL variant leading the way), Initial Operating Capabilities (IOC) for the three variants in US service are 2010 (STOVL), 2011 (CTOL) and 2012 (CV). Deliveries to Australia could start as early as 2012, but a more conservative estimate might be 2015, especially if the program encounters significant delays in either SDD or full-rate production.

The DCP allocates about AUD$12 billion for Phases 1a and 1b of Project Air 6000, which will see the acquisition of a manned air combat and strike capability. Later phases will likely see the acquisition of Unmanned Combat Air Vehicles, according to the Chief of Air Force, Air Marshal Angus Houston, who told ADM, "By 2020 I expect we will be looking at the best mix of F-35s and UCAVs. I expect that by then the UCAV will provide the best means to attack heavily defended targets. We might also expect to see UCAVs working closely with manned fighters in the air combat role."

At December's exchange rate a hundred F-35s would cost roughly AUD$6.7 billion. But a one for one replacement of the Hornets and F-111s is highly unlikely - 60-75 aircraft may be closer to the mark. Buying a single aircraft type to replace both the Hornet and F-111 simplifies maintenance, logistics support and, crucially, air- and ground-crew training. It also reduces the burden of configuration management for things like mission system, flight control and EW software upgrades.

If the F-35 CTOL variant holds its price, the platform element of Phases 1a and 1b would cost AUD$4.02 - AUD$5.02 billion at today's prices. Even allowing for a significant level of non-recurring project expenditure, this is still well below the DCP's current budgeted figure and would reduce pressure on the capital acquisition budget and free up funds for things like additional tankers and smart, stand-off weapons as well as a subsequent purchase of UCAVs.

Of course, there is no guarantee that the price of an F-35 won't rise significantly. But the whole point of the JSF program is to build an affordable aircraft - cost control is of unprecedented importance compared with previous tactical fighter projects and the Pentagon, and Lockheed Martin in their turn, simply won't be allowed by the US government to let the costs spiral out of control.

And, as the Undersecretary for Defence Materiel, Mick Roche, told ADM last month, Defence is keen to flatten the budget curve and avoid block obsolescence by acquiring aircraft incrementally, in relatively small tranches, and increasing utilisation of the aircraft in service to turn over the inventory more quickly. This, along with the

anticipated savings from the F-35's reduced logistics costs (if achieved), should ease the pressure on Defence's capital and operating budgets considerably.

Capability

The F-35 has been designed from the outset to deliver an all-weather precision attack capability which forms a node on the Network Enabled Warfare (NEW) grid being established by all three US services and their allies. It incorporates what Lockheed Martin terms 5th generation all-aspect Very Low Observables (VLO) and advanced Electronic Counter-Measures (ECM) to ensure adequate levels of survivability against the latest generations of Russian-made surface-air missile systems - the so-called 'double-digit' SAM environment..

The key to the F-35's combat capability lies not in platform performance, which breaks no new ground, but in the aircraft's ability to synthesise the various internal and off-board sensor inputs into a high level of situational awareness and targeting data for its weapons.

Overall, the aircraft has to meet 460 performance-based requirements, of which eight are absolutely paramount. The key requirements for the F-35 CTOL are: a very low radar signature; a combat radius of 590 nautical miles; the ability to mount three sorties per day per aircraft under surge conditions and two sorties per day on a sustained basis; a reduced logistics footprint of less than eight C-17 loads per squadron (compared with about 13 for today's aircraft); at least 93 per cent mission reliability (the USN and USMC demand 95 per cent); and secure voice and data links to communicate with up to 120 separate ground and air platforms and command nodes.

Avionics and connectivity

While all modern fighters aim to achieve high levels of connectivity through use of secure radios and data links (pioneered, incidentally, by the Swedes), Lockheed Martin aims to place the F-35 some 10 years ahead of its rivals in this area.

The F-35 is designed to both create and exploit tactical information, using its data links to receive and share information with other aircraft and other elements on the warfighter network.

This is a capability "that will fit beautifully into the structure we're developing in the ADF," according to Houston. "A structure of network enabled warfare where we'll have highly sophisticated command and control, surveillance reconnaissance and electronic warfare capabilities. And this aircraft will be able to connect very effectively into that environment."

All three variants will have an identical avionics and sensor suite. The F-35's radar will be built by Northrop Grumman, which is also responsible for much of the aircraft's mission system hardware and software. An all-new design, it will incorporate an Active,

Electronically Scanned Antenna (AESA). In the attack/strike role, in Synthetic Aperture Radar (SAR) mode it will detect both static and mobile ground targets. According to Lockheed Martin this will provide significantly better range and resolution than the APG-73 radar on late-model F/A-18 Hornets. The aim is to be able to identify and attack targets in all weathers, including fleeting, mobile targets such as SAM and ballistic missile launchers and enemy special forces.

In the air-air mode, ADM understands the AESA should be able to detect and lock onto targets at distances that allow the AMRAAM to be launched at the very limits of its range in certain circumstances. This, along with its low radar signature, will confer a very useful air superiority capability on an aircraft which is designed principally as a strike fighter.

The radar system is complemented by an internal, multi-spectral electro-optic system. This is a high-resolution, long (undisclosed) range target acquisition system which can also be used in the air-air mode as an Infra Red Search and Track (IRST) sensor comparable in performance (and probably superior, given advances in EO and IR technology) to that of the US Navy's current F-14D.

The EO suite also has what the company terms a Distributed Aperture System with sensor apertures all round the aircraft which provide full spherical coverage to detect missile launch and also other aircraft. This is integrated with the aircraft's navigation FLIR system as well as its EW Self-protection system and presented to the pilot through his Helmet-Mounted Sight (HMS). It also includes a laser rangefinder and target designator.

The communications system includes an inter- and intra-flight datalink. Reportedly costing more than the radar, this incorporates a SATCOM receive capability - Lockheed Martin plans to make it a two-way capability in due course - and the F-35 will also incorporate the US military's forthcoming Joint Tactical Radio System (JTRS) and exploit the Joint Variable Message Format (JVMF).

The F-35's sensor fit, allied to its communications suite, provides an inherent multi-spectral reconnaissance and intelligence gathering capability which reduces, but doesn't eliminate entirely, the need for dedicated recce sensors.

At present low-level night attack requires a two-man crew, as in the Tornado, F/A-18D Hornet and -E/F Super Hornet and the F-15E Strike Eagle. Making this a viable option for a single-seater requires a completely different approach to the cockpit environment.

The F-35's cockpit environment is quite different from that of the Hornet. It has no Head-Up Display (HUD); this function is subsumed by the pilot's HMS, which is another all-new system. The aircraft can be loaded up with Geographic Information System (GIS) data, if this is available for the operational area, to provide both wire and virtual terrain displays to enhance situational awareness.

The avionics and general cockpit environment have been designed to impose a very low workload on the pilot both in identifying and engaging targets as well as simply manoeuvring the aircraft. This is partly because there are no plans to build a two-seat variant of the F-35, and is also part of the reason why there won't be a two-seater.

Platform and Stealth

You can't achieve true stealth unless you start with a clean-sheet design, says Lockheed Martin. Contrary to some media reports, the F-35 incorporates all-aspect stealth in order to meet what Lockheed Martin calls 'very stringent' Pentagon requirements. While the company isn't allowed to talk about this, ADM understands that the X-35 technology demonstrator, which wasn't designed specifically for stealth, and an engineering mock-up which was, both demonstrated excellent stealth characteristics during testing.

The signature reductions are inherent in the shaping of the aircraft, rather than through reliance on radar absorbent materials. This makes maintenance much easier and cheaper than with earlier stealthy aircraft designs - something else which has exercised the minds of project planners.

For example, Lockheed Martin has come up with a stealthy, one-piece engine air inlet design which uses no moving parts and no splitter plates yet remains efficient at both sub- and super-sonic speeds. The nose-mounted EO sensor and targeting system uses a stealthy aperture and even the axi-symmetric circular jet nozzle incorporates stealth characteristics, the company says. High-precision manufacturing processes ensure panel fits which don't create radar reflectors.

The F-35 is required to have "F-16-like" performance. This is respectable rather than awesome, but the decision to carry fuel and armaments internally provides significant advantages, according to figures supplied by the company.

In air-air combat configuration, with internal fuel and weapons, the F-35 CTOL variant can sustain 9g in a turn, roughly the equivalent of a clean F-16 - that is, without external tanks and weapons. It has a much greater wing area than either the F-16 or F/-18A/D and carries 18,307lb of internal fuel, compared with the Super Hornet's 14,708lb, the Hornet's 10,800lb and the F-16's 7,162lb. And its combat radius of 590 miles is greater than that of the F-16 with two external 370 US gallon drop tanks. The F-35 CTOL's tactical acceleration in combat configuration is the rough equivalent of a 'clean' F-16C and easily greater than an F-16C in its normal combat configuration with external missiles and tanks.

The F-35 has two internal weapons bays sized to carry two AMRAAMs or one AMRAAM and a 2,000lb strike munition each. The strike munitions could include all variants of JDAM and a range of other munitions including the JSOW, Hellfire and ASRAAM.

What it can't carry internally are the AIM-9X Sidewinder, JASSM, Storm Shadow, Maverick, Harpoon and any except the very smallest member of the Paveway laser-guided bomb family. These, along with ferry tanks, would need to be carried externally - the aircraft has eleven stores stations, three plumbed for fuel tanks. Sidewinders can also be carried on a further two proposed wingtip stations. Interestingly, Lockheed Martin has not been asked to integrate the AGM-142 Popeye with the F-35, signalling that in Australian service this weapon will retire with the F-111.

The AIM-9X's IR seeker head must be exposed in order to acquire the target before launch. That means carrying it externally and compromising the ultimate stealthiness of the aircraft, unless operators elect to fly combat air patrols or strike missions with four internally-mounted AMRAAMs instead (the F-35 can also carry a further two AMRAAM externally if stealth isn't a priority). The ASRAAM, which will be used by the RAAF, RAF and Royal Navy, has a 'lock after launch' capability so can be carried internally and doesn't compromise the aircraft's radar signature.

The RAAF is also understood to be exploring the possibility of using the internal weapons bays for other purposes. Lockheed Martin has confirmed it received inquiries from Canberra about the possibility of plumbing the bays to carry additional internal fuel tanks, as well as recce packs containing more sensors.

In the strike/recce role, nothing matches the range/payload capability of the F-111. However, the Chief of Air Force, AM Angus Houston, said at the time of the JSF announcement, "With external fuel tanks and air-to-air refuelling, it will have the capability to do what the F-111 does."

This prompts a couple of obvious questions: how many tankers would be required to support an F-35 strike and recce capability equivalent to that currently provided by the F-111C? And to what extent can relatively light, precision-guided stand-off weapons make up for some of the F-111's unique range/payload capability?

A relatively small, stealthy platform with good EWSP will be inherently more survivable against most air and ground threats than the F-111. Stand-off weapons reduce the need for blistering low-altitude dash speeds over the target and reduce exposure to enemy air defences. The F-35 is designed, like the F-111, for night and all-weather operations. Whether or not it can match the F-111's terrain-following flight profile isn't clear; and given the capabilities of modern stand-off weapons it's not certain this actually matters very much, though it's a capability the RAAF would probably rather have than not.

What about weapons? The RAAF's only stand-off strike weapons at present are the Harpoon anti-ship missile and Paveway LGBs; Defence has selected JASSM as the RAAF's Follow-On Stand-Off Weapon, but this is too big to be carried internally by the F-35, so will be carried externally. If the RAAF wants a stealthy stand-off strike capability it must acquire a weapon which fits into the F-35 weapons bay; JDAM and JSOW are obvious candidates, and the RAAF will undoubtedly be watching the

European F-35 customers to see if any of them try to integrate stand-off weapons of their own with the aircraft.

In the air-air role the F-35 doesn't pretend to have the sheer speed and Specific Excess Power (SEP) of a MiG-29, Su-27, F-15E or F-22, but should still be highly effective against the majority of adversaries in Beyond Visual Range (BVR) combat, which requires a small signature and good sensor and weapon performance. In Within Visual Range (WVR) combat, persistence, counter-measures, agility and weapon performance are paramount.

The RAAF has settled on the AMRAAM and ASRAAM as its BVR and WVR missiles of choice, and these will be baseline fit on the JSF. Effective BVR capabilities, helmet-mounted sights and the advent of extremely fast, agile, all-aspect infra red-guided WVR missiles have changed the nature of air combat dramatically in recent years. The right weapon and sensor fit, stealth and ECM, and the fusion of sensor data into situational awareness information for the pilot are more important now than raw airframe performance. The F-35 promises to be a good performer in these areas - on paper.

And there's the rub: Defence has committed itself to the F-35 largely on the basis of its faith in the aircraft's design, cost and the project delivery process, not the proven article.

The F-35's capability will be the aggregate of its platform, stealth, mission system, connectivity and weapons performance. Will it be superior to the other contenders for Air 6000? That remains to be proven, and delaying the decision to acquire the F-35 until 2006 will probably make little difference.

While the Eurofighter, Rafale, Super Hornet and Gripen will all be proven operational platforms by 2006, supported by plenty of user feedback, the final capability of the F-35 will still not be proven. Choosing it over its rivals will still require an act of faith. However, a convincing performance by the first production-configuration prototype in 2005 will be necessary for the US government to approve LRIP in 2006 - that would probably satisfy Canberra as to the aircraft's actual and potential capabilities and costs.

Still, the avionics and communications integration and development task promises to be huge, and disappointments and setbacks are inevitable. Defence's faith in the Joint Strike Fighter - the aircraft as well as the overall project - is likely to be very sorely tested.

The issue of Australian industry involvement and technology access is addressed separately, on page xx. This element of the project breaks new ground, as the project does everywhere. There is no comfort zone for Defence and for Australian contractors because there are no precedents and models for what the Pentagon, Whitehall and Lockheed Martin are trying to achieve.

It's probably safe to predict that the F-35 will meet most of its capability and performance targets; the big unknown is whether the project will stay on schedule and within budget. However, critics of the decision to join the JSF program have yet to

demonstrate that any alternative would be technically superior or more cost-effective over the projected life of type of the aircraft.

ENDS