Submission No 20

Inquiry into Australian Defence Force Regional Air Superiority

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Joint Standing Committee on Foreign Affairs, Defence and Trade
Foreign Affairs Sub-Committee

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Subject:	AIR POWER AUSTRALIA SUBMISSION - APA-SUB-2006-01

To:

The Hon Bruce Scott
Chair, Defence Sub Committee
Joint Standing Committee on Foreign Affairs, Defence and Trade

Dear Mr Scott,

Air Power Australia is pleased to provide our submission entitled, 'Attaining Air Superiority in Region' as our contribution to your Committee's inquiry into Australian Defence Force regional air superiority and the public debate we advocate now needs to happen.

For both Dr Carlo Kopp and myself, this has been a struggle of enormous proportions, spanning over half a decade, which has changed forever the way we view those grouped within the upper echelon of our otherwise outstanding armed forces. Sadly, this is not how it could nor should have been. Your committee should not have been required to inquire into this matter and every Australian should now be asking the question, "Why?"

The issue before us all and, moreover, the answer to this question, keenly brings into focus the words of our Prime Minister, the Hon John Howard, when he said –

> ***'I believe that each generation of Australians is obliged to leave our country in better shape than they found it'.***

We wish the Committee every success in its endeavours and stand willing to assist should our services be needed.

Yours sincerely,

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"Air Power Australia - Defining the Future"

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Attachments: This document employs a large number of charts, plots and diagrams. These have been implemented in full colour to improve readability. While we have invested a lot of effort into ensuring best possible contrast when printed in black and white, in general colour rendering still reads better. We strongly request that any hard copy distributed to the committee be printed in colour.

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Inquiry Into Australian Defence Force Regional Air Superiority: Attaining Air Superiority In the Region

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Attaining Air Superiority in the Region

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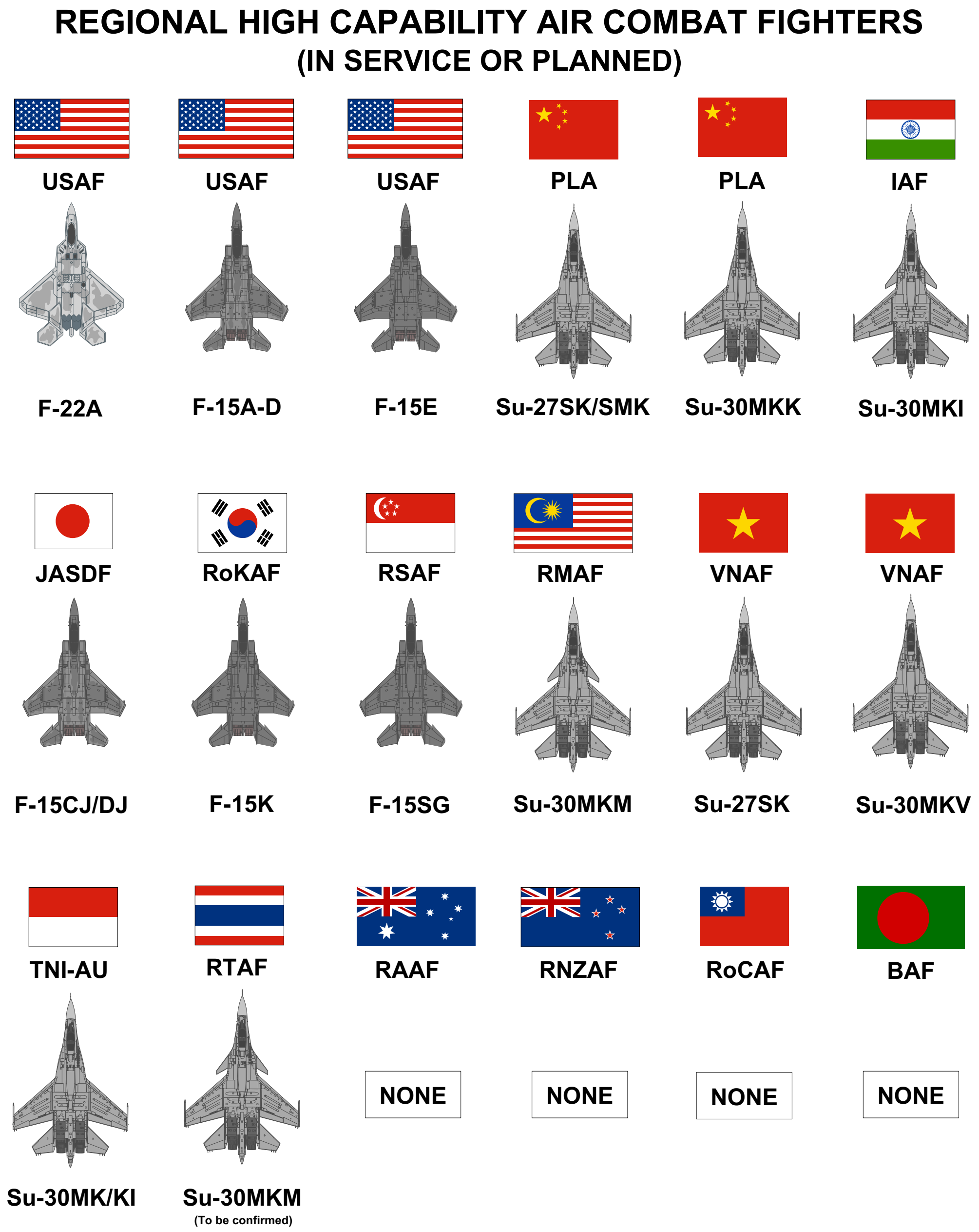

Figure 1: *Perhaps the most visible change in the region following the end of the Cold War has been the proliferation of large 'high capability' category air superiority fighters. This chart illustrates which types have been acquired or deployed by regional nations. Australia currently operates the smaller 'low capability' F/A-18A and plans to acquire the small 'low capability' Joint Strike Fighter. This places Australia firmly in the same force structure planning bracket as Taiwan, Bangladesh and New Zealand. This division of fighters into 'high capability' and 'low capability' categories is based on the United States Air Force 'High - Low Mix' model, abbreviating the more formal 'high capability and performance category' and 'low capability and performance category'. Examples of the 'high capability' category include the F-14, F-15 and F-22, examples of the 'low capability' category include the F-16, F/A-18 and planned Joint Strike Fighter. (C. Kopp).*

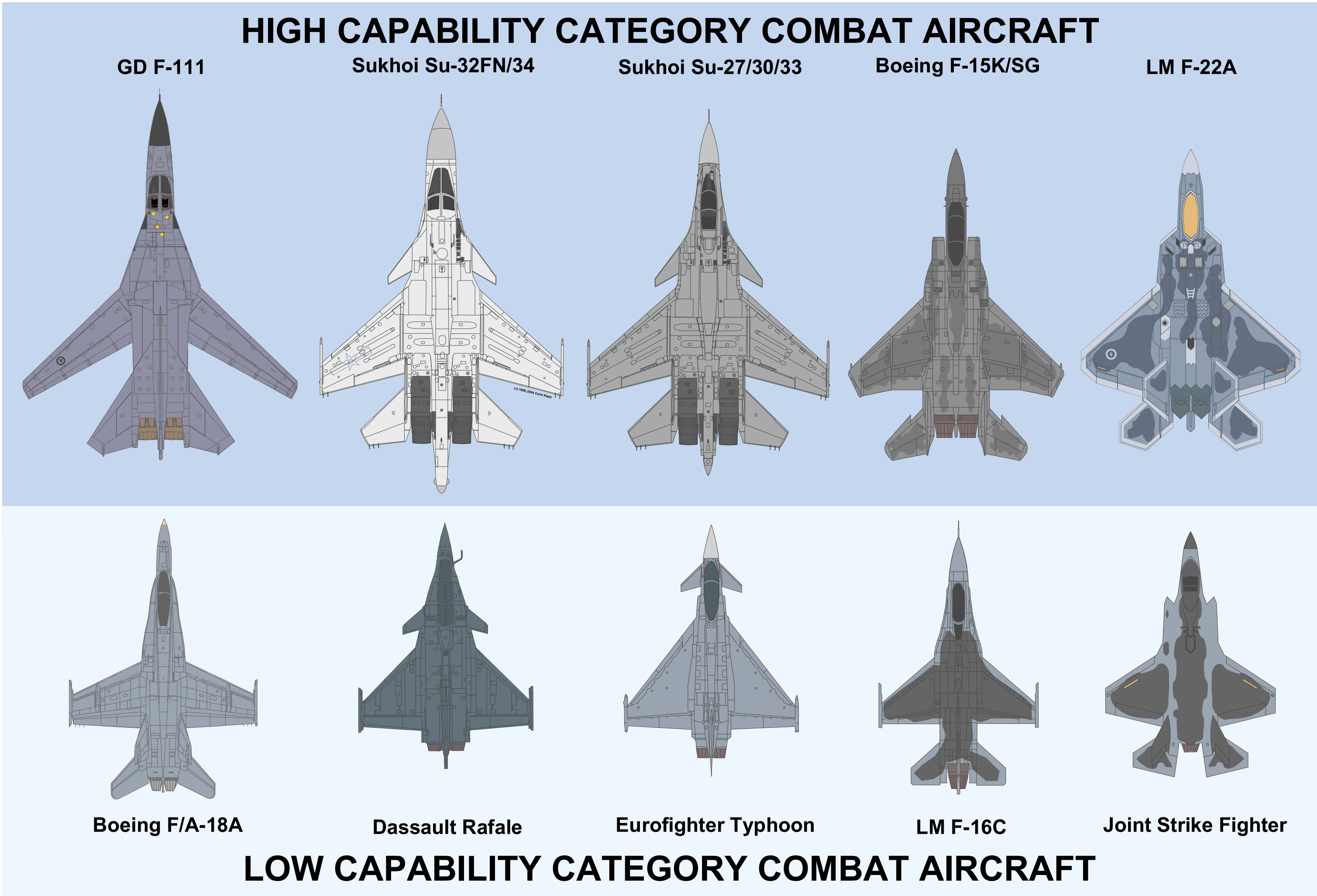

Figure 2: *Relative size comparison of high capability category and low capability category combat aircraft. Typically, high capability category combat aircraft are about 50% larger and significantly more capable than low capability category designs. Historically, low capability category designs were built as supplements to high capability category designs and intended for less demanding roles (C. Kopp).*

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Executive Summary

Australia at this time stands at an important crossroad, and choices to be made in the near future will determine Australia's strategic relevance in the region, and globally, for decades to come.

The choices in question are those which determine what kind of air force Australia will possess over coming decades, and the ability of this air force to achieve air superiority in a regional conflict.

Air superiority is defined as the ability to achieve and maintain control of the air, which is the ability to conduct aerial operations without hindrance by an opponent, and the ability to deny the same to an opponent. Air superiority is achieved by a combination of superior fighter aircraft, strike aircraft, weapons, surveillance aircraft, aerial refuelling tanker aircraft, as well as superior pilot ability and training.

Of all of the goals a defence force might aim to achieve in conflict, air superiority is by far the most difficult. Without air superiority, an opponent can hold at risk or destroy air, land and naval forces, critical national infrastructure, industrial plant, and finally, aerial and maritime lines of communication. Air superiority is the precondition for all other military operations of significant scale.

This submission analyses current planning for the RAAF's future, against funding and risk measures, and developing or deployed regional capabilities for air superiority. It draws the following series of conclusions:

The planning model devised for the Joint Strike Fighter capability is not viable, both in terms of return on investment in capability, credible delivery timelines, and risk.

The planning model for the interim F/A-18A capability is not viable as the return on investment in capability and additional service life is very poor, while incurring significant risk.

Analysis of acquisition costs and operational economics indicates that a force mix of F-22A and upgraded F-111 fighters is both cheaper and more capable than the proposed plan based on service life extension of the F/A-18A and acquisition of the Joint Strike Fighter.

There are compelling strategic, technological, operational and budgetary reasons why the F-22A Raptor is a better choice than the Joint Strike Fighter as a replacement for Australia's F/A-18A Hornets. These include unchallenged lethality and survivability, affordable return on investment in capability, and very long effective service life.

The industrialisation of Asia, especially China, has resulted in an unprecedented growth of national wealth, and thus in the largest arms buying spree globally, since the last decade of the Cold War. Therefore, in any substantial future regional contingency, Australia will likely have to confront the full spectrum of modern air force capabilities, including high capability category fighters, aerial refuelling tankers, Airborne Early Warning and Control (AEW&C) systems, advanced smart weapons, cruise missiles, missiles designed to destroy AEW&C systems, digital networks, support jamming systems, and should China be involved, strategic bombers.

The United States is confronting serious 'strategic overstretch', and faces budgetary problems which will impact its long term modernisation plans and available force size. Therefore, the United States may have serious difficulty in responding quickly to Australia's needs, with the required force strength. Therefore, Australia needs to plan to perform independent operations in the region, especially when confronting regional air power.

The notion that regional contingencies geographically outside South East Asia would only be dealt with as part of a US led coalition is neither realistic nor supportable.

Dealing with future regional contingencies will require that Australia develop the capability to decisively defeat advanced Russian Sukhoi fighters, strategic bomber aircraft, subsonic and supersonic cruise missiles, and the capability to execute 'counterforce' long range strikes to a distance of at least 2,500 nautical miles, with a credible number of aircraft.

Therefore Australia will have to invest in a high capability category air combat fighter, the F-22A, retain the high capability category strike capability, currently in the F-111, acquire additional Wedgetail systems, acquire additional aerial refuelling tankers, acquire airborne support jamming systems, acquire much more intelligence, surveillance and reconnaissance capabilities, restore lost support capabilities, and upgrade the aviation fuel replenishment infrastructure of northern airfields.

Should Australia fail to develop these capabilities, it would most likely not achieve air superiority in a regional conflict, with concomitant losses in ADF equipment and personnel, and subsequently, significant material losses to economic infrastructure, especially in the mining and energy industries.

Extensive analysis indicates that the Joint Strike Fighter is not suitable for the kind of operations likely to be encountered in the region, as it is being designed for less demanding roles, especially supporting ground troops on the battlefield.

Australia's best choice both in strategic, budgetary and risk terms is to invest in the F-22A Raptor as its future air combat fighter.

Structure of Submission

The issues which contribute to an assessment of Australia's capability to achieve air superiority in the region are complex in detail, even if simple in concept. Three aspects are of paramount importance - Funding and Risk, Regional Capability Growth and means to Achieving Air Superiority. Accordingly, this submission is structured in three parts, each dealing with a specific aspect of the problem.

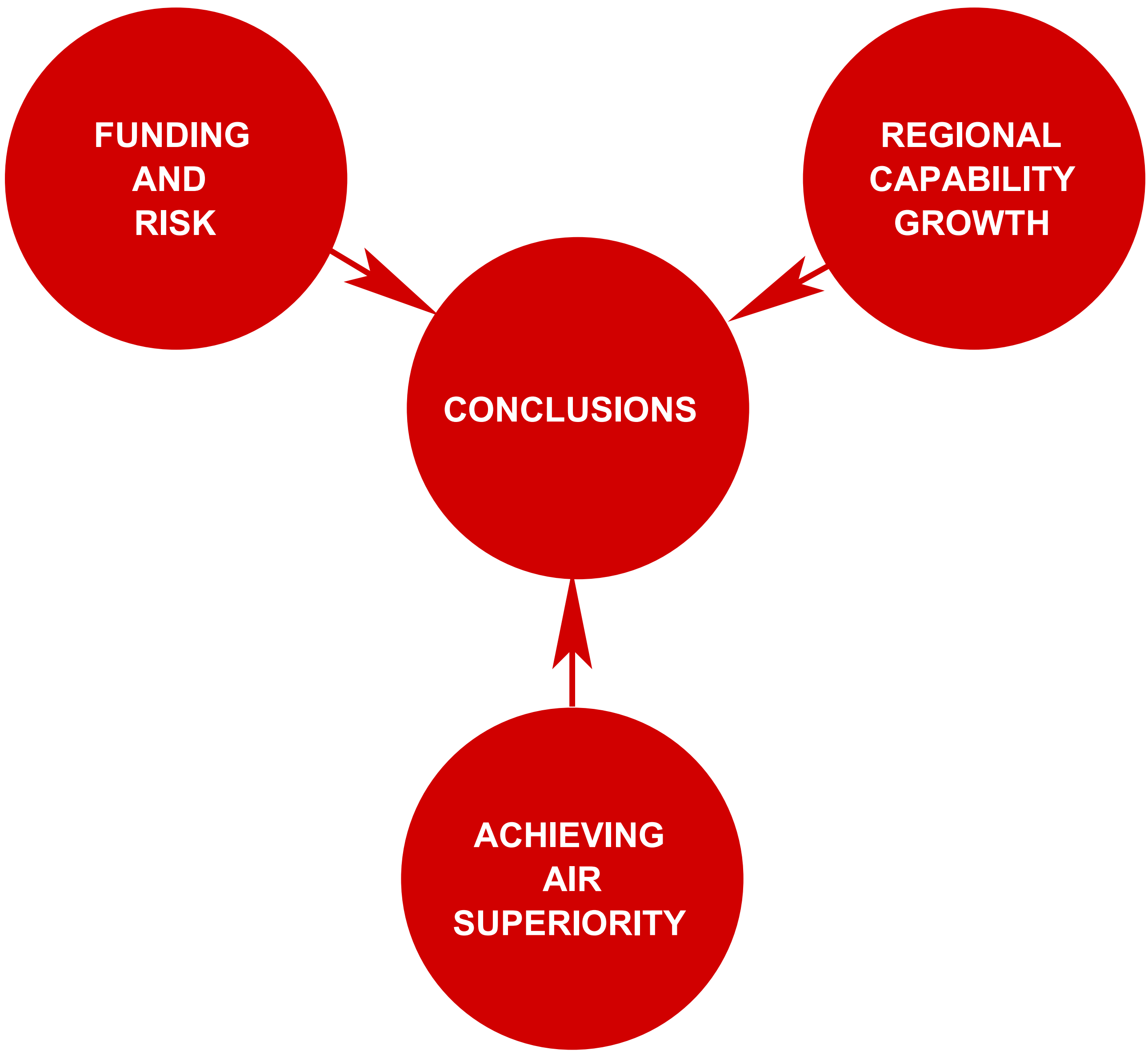

Figure 3: *Submission structure.*

In addition, several Annexes are included, containing references and supporting materials.

1 Funding and Risk

This section analyses the funding and risk factors which will significantly influence and thus constrain the intended acquisition of the Joint Strike Fighter, and interim Air Combat Capability to be provided by upgrades of the F/A-18 Hornet. It then outlines the single most capable and cost effective alternative strategy, and summarises extensive analytical findings.

1.1 Why the Joint Strike Fighter Funding Model is Not Viable

Senator FAULKNER - *Let me put the question to you this way, because we are very short of time. I ask you directly: what is the estimated cost per (JSF) aircraft now?*

Air Chief Marshal Houston - *It is $US45 million. . . . *. . . The most recent estimate of the average unit recurring flyaway cost of the JSF conventional takeoff and landing aircraft is approximately $US45 million.*

Senate Supplementary Budget Estimates Hearing, 02 November 2005

An important aspect of any financial analysis or funding model (or any analysis, for that matter) lies in the accuracy and the precision of the language employed to define the terms that are used. The obvious corollary to this is equally important, being the correct use of the correct terminology and definitions in the correct sense.

Finance and schedule issues form the basis of any funding model. The public representations of Defence officials on the finance and schedule aspects of the Joint Strike Fighter (JSF) and how they relate to the New Air Combat Capability (NACC) Project (AIR 6000) are replete with omissions of fact, imprecise language, and the incorrect use of terminology and definitions. As to whether such omissions, imprecise language and incorrect usage are intentional behaviour aimed at encouraging inferences of perceptions rather than facts, or representative of people who don't know what they don't know trying to deal with things they don't understand is for others to determine.

Therefore, putting the matter of cause (or blame) to one side, the above extract from Hansard is but one example of the results arising from such forms of behaviour. The Chief of the Defence Force (CDF) is representing to the Australian Parliament (and, thus, the people of Australia) that the estimated cost to Australia for the JSF, on a per aircraft basis, is $US45million. This was certainly what Senator Faulkner was asking and one could be forgiven for inferring this was the intention of CDF's response.

However, the actual cost to Australia, on a per aircraft basis, will be significantly higher for the following reasons:

1. The figure of $US45million is in 2002 dollars [1] or Base-Year Dollars [2] which does not take

into account economic inflationary effects or, moreover, the costs that will apply at the time of procurement, currently planned for 2012.

2. The term "*average unit recurring flyaway cost of the conventional takeoff and landing aircraft*" represents only a portion of the average unit flyaway cost which, in turn is only a part of the average unit procurement cost which is defined as –

   Average Unit Procurement Cost (AUPC) *is calculated by dividing total procurement cost by the number of articles to be procured. Total procurement cost includes flyaway, rollaway, or sailaway costs (that is, recurring and non-recurring costs associated with production of the item such as hardware/software, Systems Engineering (SE), engineering changes and warranties) plus the costs of procuring Technical Data, training, support equipment, and initial spares.*[3]

   A diagrammatic representation of this costing hierarchy is shown in Figure 4. Note this definition does not include any costs for research, development, test and evaluation (RDT&E) which, in US DoD budgeting terms, are costed and funded differently to the procurement budget.

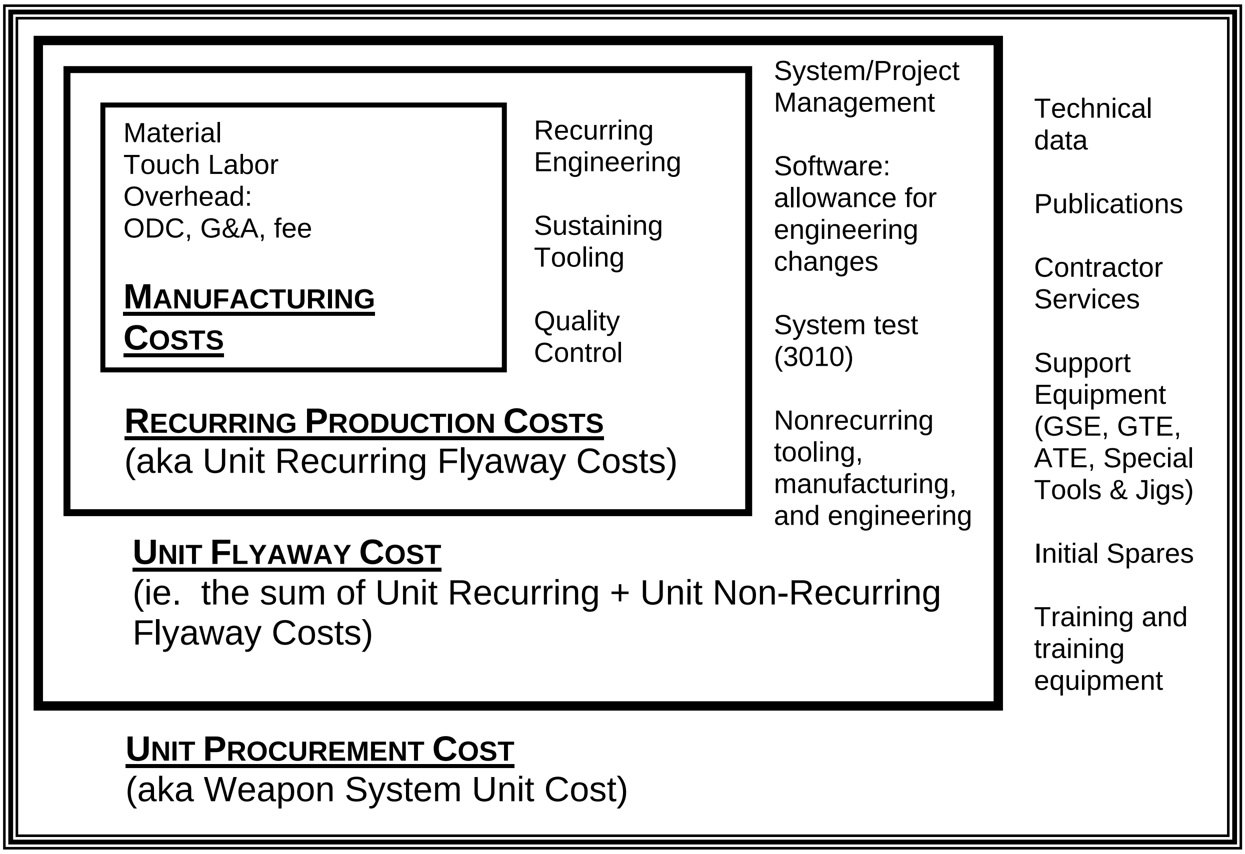

Figure 4: *Graphical representation of costing terminology used (globally) in defence acquisitions (P.A. Goon).*

3. The word '*average*' refers to the whole of the presently planned production of conventional takeoff and landing (CTOL) aircraft; some 1,763 units according to the September 2005

JSF Project Office Briefing or, put more simply, the unit recurring flyaway cost of a unit somewhere after CTOL aircraft number 880 rolls off the production line. In relation to the cost to Australia, some of the significance of the use of this term '*average*' may be gleaned from the following extract from Hansard which was interposed at the asterisk (*) in that above –

Dr Gumley - *Provided they are not the very first aircraft coming out. The very first ones coming out of the production factory are dearer than that. Once the production line settles down at Lockheed Martin, it comes down to $US41 million <sic>.*

4. Based on the various reports on JSF Program costings to the US Congress, in particular those in the US DoD Budget Papers and the Defense Acquisition Executive Summary Selected Acquisition Reports (SARs) since 1998, the following information may be derived :

   (a) As a result of the Defense Acquisition Executive (DAE) Milestone B approval, the JSF Program entered the SDD Phase in October 2001, and $US196,600.0 million of procurement funding for 2,866 production aircraft were added to the budget, in addition to the already allocated development (SDD) costs. Therefore, in 2001 current year dollars, the estimated average unit procurement cost for the program (across all three planned types) was $US68.6 million. This was in 2001, before Australia committed to join the SDD Phase of the JSF Program.

   (b) The US DoD split acquisition program costs into two main budget lines - the Procurement Budget, being the funding for those items that are to be delivered to the department; and, the RDT&E Budget, being for funding what can be termed, collectively, as the 'development costs'. The budget for the SDD Phase of the JSF Program is a good example of the latter. The SDD Budget is reported under the RDT&E Budget line for the JSF Program and is presently sitting at around $US42,000 million. The RDT&E budget expenditure for developing the F-22 (Raptor) was around $US24,800 million in FY2002 dollars.

   (c) In December 2004, the SAR showed that for the reduced number of 2,458 production aircraft, the Procurement Budget line for the JSF was $US214,617.6 million. Using the correct definition, this results in an estimated average unit procurement cost for the program (across all 3 planned types) of $US87.3 million in current year (2004) dollars.

   (d) Current (2005) production plans under the US DoD Procurement Budget for the JSF Program are for 1,763 CTOL aircraft for the USAF and a combined total of 680 aircraft, made up of 260 carrier variant (CV) and 420 short takeoff and vertical land (STOVL) aircraft, for the Department of Navy. The CTOL build numbers being the larger will skew any cost averages across the three planned types. A simple interpolation shows the estimate of the average unit procurement cost for the CTOL variant to be $US81.3 million in 2004 dollars.

   (e) Representations by senior defence officials to the Australian Parliament are that current plans have acquisition of the JSF commencing around 2012. The following table shows the effect of economic inflation factors from 1% to 3% per annum on the above estimated average unit procurement cost (AUPC) for the CTOL variant of the JSF for procurement in FY2012.

JSF CTOL AUPC FY2004	Annual Inflation Factor	JSF CTOL AUPC FY2012
$US81.3 million	1%	$US88.0 million
$US81.3 million	2%	$US95.2 million
$US81.3 million	3%	$US103.0 million

Table 1: The Effect of Economic Inflation on Costs of Planned Australian Buy

(f) Though the JSF Program is still in the SDD Phase, monies from the Procurement Budget line will be accessed, as has been the case in other US acquisition programs, such as the F-22. The recently released DoD 2007 budget seeks provision of some $US770 million (that is, $US1,015.0 million minus the $US245.0 million for "the advance procurement of 8 CTOL . . . aircraft") from the USAF line of the Procurement Budget in order to fund the "procurement of the first lot of 5 Conventional Takeoff and Landing (CTOL) aircraft for the Air Force". To this must be added the $US118.4 million funding in the FY2006 budget authorised last year for the advance procurement of these aircraft. Once again, applying the correct definition results in an average unit procurement cost across this lot of five (5) aircraft of $US177.7 million per aircraft.

(g) The US DoD 2007 budget papers also show the average unit procurement cost for a buy of 24 production F-22 Raptor aircraft in 2006 as $US156.9 million per aircraft in current year dollars. The previous buy of 24 aircraft in FY2005 was at an average unit procurement cost across this lot buy of $US170.6 million per aircraft. This demonstrates the descalation in costs that can usually be achieved when an aircraft is in full rate production. From a risk management perspective, the F-22 Program is over the 'risk hump' and on what is called the 'front side of the risk curve'. Similarly, an aircraft program that is still in the early stages of development, such as the JSF, is referred to as being 'on the backside of the risk curve'. As history and the experiential based rules of Norm Augustine[4] and Kelly Johnson[5] show as well as prudent risk management methodologies consider, costs are bound to increase during the 'backside of the risk curve' phase of a project. The more complex the project, the more marked the cost increases. In a similar vein, based upon the experience and wisdom of those who have gone before, cost estimating of those elements in a project which require project maturity to better define (eg. technical data, training, support equipment and initial spares) are quite 'rubbery' early in the project's life. Again, history and empirical measures show that the estimates of Unit Procurement Cost (UPC) early in a development project invariably end up more closely resembling the Unit Flyaway Cost estimate in the latter part of the development phase.

(h) Since money is a general measure of the resources and levels of effort required to sustain a project through to an outcome then, by definition, costs cannot be independent of the outcome. The notion of cost as an independent variable (CAIV), though a laudable project management philosophy for raising consciousness on costs, is mostly unsupportable, mathematically and logically, and presents a serious propensity for skewing risk management into the realm of the naïve. According to senior defence officials such as the CDF and the chief architects of the JSF decision, AVM (R'td) Ray Conroy, Mr

Mick Roche and the former Head of Industry Division, Mr David Learmonth, CAIV is meant to elevate cost to the status of a performance parameter. As such, it is meant to promote the optimisation of project goals early in the project by trading off the variables of cost, schedule, risk and performance. Even the most basic of common sense considerations shows there are serious incompatibilities between the parameters of cost, schedule and risk which all seek minima and the parameter of required performance which unlike the other three is supposed to be the primary driver of any program. In fact, of all four of these parameters, the required functions and performance (ie. war fighters' needs) is what a program is all about to begin with and the basis upon which the other three are determined and developed through the application of estimating and risk management methodologies. Poor initial estimating and flawed or incomplete risk assessment/management of this parametric trilogy should not be reason for downgrading or otherwise minimising the matching of capability to the war fighters' needs.

5. The results of an independent, parametric cost projection of an Australian buy of 100 Production Block 2 and/or Block 3 JSF aircraft in 2012 were provided to Defence in 2003 and again in 2005. This analysis assumes the development and production schedules being advised by Defence can be maintained. The analysis estimates the unit procurement cost will be somewhere between $US112 million and $US120 million per aircraft in FY2012 dollars.

6. In terms of these estimated costs in Australian dollars, a prudent approach would be to convert these amounts to Australian dollars using the Australian Reserve Bank (ARB) forward projection of the exchange rate in 2012 minus a risk hedge of, say, five points. Unfortunately, such an ARB projection is not readily available. However, an indication can be gleaned by applying the same methodology to an anecdotal mean of the exchange rate over the past 12 months of 0.7500, resulting in estimates of the unit procurement cost being between $A160 million and $A171.4 million per aircraft in FY2012 dollars. For a procurement of 100 CTOL JSF aircraft, this would require the expenditure of between $A16,000 million and $A17,140 million in order to purchase the aircraft with the requisite "*Technical Data, training, support equipment, and initial spares*", though, as highlighted earlier, experience shows that early UPCs more closely resemble the actual UFCs determined in the latter stages of the development phase. What are not included in these estimates are the costs for project management, any Australian unique integration requirements, in-country infrastructure/facilities or any consideration of life cycle support and operational costs.

7. This analysis takes into account the higher price that will have to be paid in buying early in the production from the Low Rate Initial Production (LRIP) phase of the JSF Program. It also considers an economic inflation factor of 1% per annum over the period 2004 to 2012. What this analysis does not consider are the effects of the reported "*guaranteed waiver of at least the SDD investment (*$US150million*) from the Non-Recurring Engineering cost*" nor any waiver resulting from Australia acquiring aircraft through the Production, Support and Follow-on Development MOU which has been reported by Defence to be "*valued at as much as US$1billion*"[6]. These two aspects are addressed later in this section. The analysis also does not take into consideration any effects on cost due to any reduction in overall production build numbers in the JSF Program.

8. In recent times, there have been some interesting statements forthcoming on the effect of

reductions in the production numbers on costs. The prime manufacturer has been reported as saying –

"There's a couple of different ways to look at flyaway costs," Burbage continued. *"One is, the number that you read about is average unit recurring flyaway cost, that's a number which is build rate and quantity dependent, where if you put all the airplanes on a curve, you can find an average. You may not find any airplane which actually costs that amount, but about half the airplanes will be more than that and about half will be less. As the unit recurring flyaway cost moves around, let's say the (US) Air Force decides to buy a few less airplanes and we bring the program in a little bit, the average unit recurring flyaway cost may go up, but the actual cost of any airplane doesn't change, it's just the average number on the curve. Sometimes people think the cost of their airplane is going up if the air force buys fewer airplanes – its really not the case unless you're buying airplanes on the very end of the buy."*

Tom Burbage, JSF Program Head, Interview with Andrew McLaughlin,
Published in Australian Aviation (Nov 05)

The content of this statement, as reported, may not be intuitively obvious to some and may invoke in the mathematically minded the question of "How can this be?". However, as the graphical representation in Figure 5 shows, this statement is, as far as it goes, quite correct. Any reduction in build numbers will come off the back end of the production run. Since the URFC is the recurring cost of production for a given aircraft and, though a reduction in production numbers may cause the average URFC to increase, the recurring cost for producing a particular unit or aircraft tail number within the remaining production run should not change.

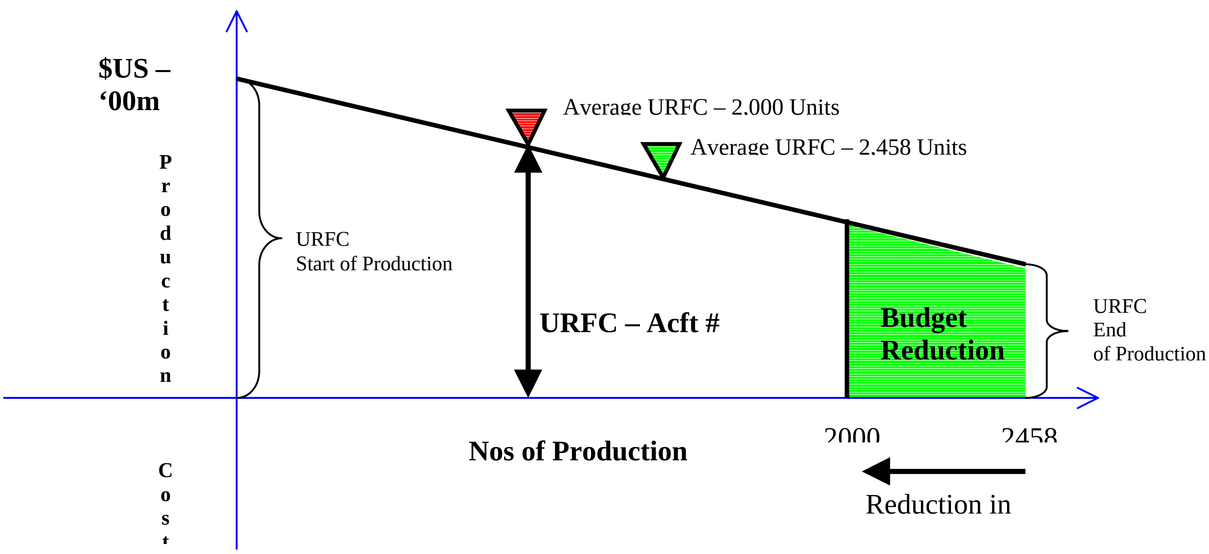

Figure 5: *JSF Unit Recurring Flyaway Cost (URFC) model (P.A. Goon).*

9. However, unit recurring flyaway cost is only a part of the overall cost of production, let alone procurement, of a weapon system. What has not been included, to date, in the representations

from Defence is the non-recurring costs of production which, when combined with the unit recurring flyaway costs (URFC), make up the unit flyaway cost (UFC). Therefore, Figure 5 and the related word picture is only part of the story on costs.

10. The diagram in Figure 6 provides a more complete picture, in a simplified graphical sense, of the JSF Costing Model up to what is termed the Unit Flyaway Cost. In this example, the reduction in budget that is achieved comes from not having to expend the URFC of the last 458 aircraft in the original planned production run. This budget saving is represented by the green area under the curve.

    However, the unit non-recurring flyaway cost (UNRFC) is originally derived by taking the non-recurring costs of production and amortising these across the total build number. If, as in this example, the build numbers are reduced, then the non–recurring costs of production (plant and equipment, system/project management, tooling, allowance for engineering changes, system test, etc.), in the main, still have to be met. This is achieved by amortising UNRFC of the 458 aircraft removed from the production across the remaining number of units to be built, as shown in red in the above figure.

11. In terms of total procurement, the costs for training and training systems, technical data, support systems, initial spares, contractor fees and government charges needs to be added to the UFC to determine the unit procurement cost (UPC). Further, by adding in the costs for project management, Australian unique integration requirements, in-country infrastructure/facilities, and life cycle support and operational costs, the total project unit cost (TPUC) can be derived. Multiplying the TPUC by the number of aircraft procured, the resulting figure should, at least in theory, match the budget in the Defence Capability Plan (DCP).

12. Clearly such a matching cannot be achieved using the figures and advice provided by the Department of Defence. A strong indicator of how this situation has come about may be seen in a letter[7] dated the 7^{th} of December last, in which the former Defence Minister's Chief of Staff, Mr Andrew Buttsworth, advised that :

    "Defence has provided the following information:

    - *Cost as an Independent Variable (CAIV) is a philosophy which elevates cost to the status of a performance parameter. CAIV promotes the optimisation of project goals early in the project by trading off the variables of cost, schedule, risk and performance.*
    - *The average unit recurring flyaway cost is the average cost of the aircraft over the entire buy. That is total cost of aircraft purchased divided by total aircraft purchased.*
    - *The unit recurring flyaway cost is the cost of an individual aircraft purchased within a specific year.*

    The Defence Capability Plan has allocated approximately $A12 billion for up to 100 Joint Strike Fighters. This equates to an average total project cost of approximately $A 120 million per aircraft. Apart from the cost of the aircraft themselves, approximately 60 per cent of project cost, this amount includes a range of broader project costs including, but not limited to, training systems, support systems, integration requirements, project management costs and facilities requirements."

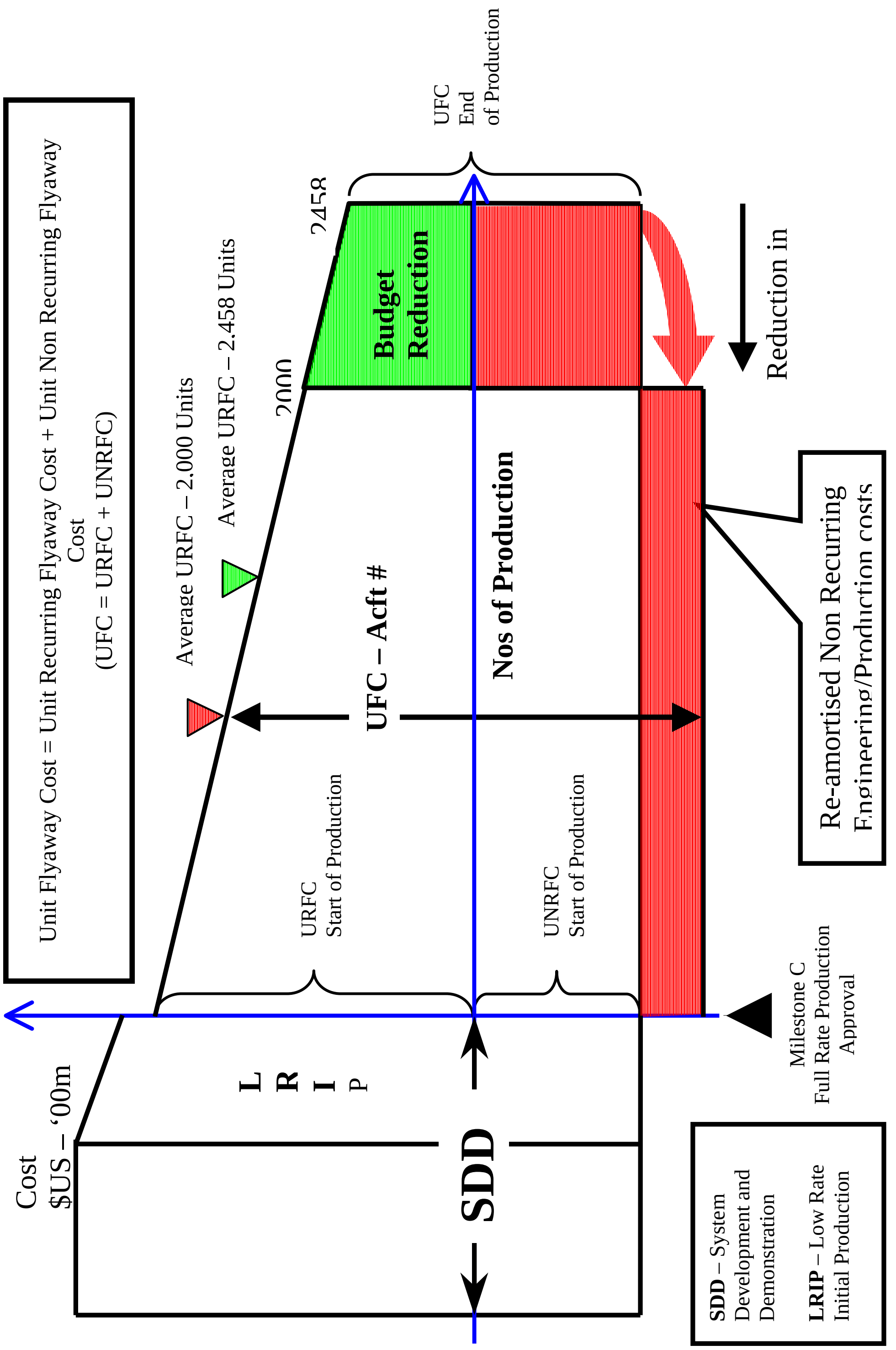

Figure 6: *Graphical representation of JSF Unit Flyaway Cost (UFC) model (simplified for clarity) (P.A. Goon).*

A review of correspondence, media releases, public statements, and submissions to the Parliament reveals that this letter is the first time most of these statements have been seen, outside the Department. Even a cursory look at this advice from senior defence officials to the Office of the Minister for Defence shows there are omissions of fact, imprecise language and the incorrect use of standard terminology and definitions.

13. For instance, if one were to take these definitions provided to the Minister at face value and then use them for assessing the US DoD Budget Papers then, by rights, the total US DoD Procurement Budget for the JSF could be slashed by more than half the existing figure. Clearly this is not the case. However, two additional pieces of useful information may be derived from this letter.

14. As stated, approximately 60 per cent of the average total project cost of approximately $A120 million is for the aircraft themselves or some $A72 million per aircraft. At a current exchange rate of, say, 0.7500, this equates to an average cost per aircraft of some $US54 million. It is unlikely numeral displacement or dyslexia are to blame for this mismatch with the CDF's advice to the Parliament of the figure of $US45 million.

15. In the corollary, approximately 40 per cent of the project budget, that is some $A4,800 million total or $A48 million per aircraft, has been estimated by senior defence officials for "*a range of broader project costs including, but limited to, training systems, support systems, integration requirements, project management costs and facilities requirements*". At this point in the JSF Program and because earlier identified risks are now materialising, a prudent approach to costing in the Defence Business Case for the JSF would be as follows –

    (a) Take the best estimate of unit procurement cost (UPC) from the JSF Program costing/budget documentation from the USA;
    (b) Consider this '*early in the program*' estimate of UPC as what will ultimately be the unit flyaway cost (UFC) at the end of the development phase of the project; and,
    (c) Add to this the unitary figure derived from the best estimate of costs for all those additional aspects which, when added to the UFC, will result in the total project unit cost (TPUC).

16. Clearly, a more accurate way to do this would be to use the data from the JSF Program Office costing models. However, since we do not have access to an approved version of this data, a reasonable approximation can be derived from the figures above, as follows:

    - Average UPC – CTOL (FY2004 dollars) $US81.3 million
    - Currency conversion at exchange rate = 0.7500 $A108.4 million
    - Add costs for determining TPUC ($A48 m) $A156.4 million

    This approach has resulted in a project unit cost figure of $A156.4 million dollars per aircraft for prudent budgetary purposes. However, the reader should note that this figure is in the 'current year dollars' of the base figures from which it has been derived, nominally 2004 year dollars.

LSN	COST ITEM	AMOUNT		UNITS	TOTAL OVER 10 YEARS	PER ANNUM	PER DAY
		USD	AUD				
1.0	**SDD TOTAL EXPENDITURES**			**Sum**	**$317,790,714**	**$31,779,071**	**$122,227**
1.1	SDD Investment	$150,000,000	$214,285,714	1	$214,285,714	$21,428,571	$82,418
1.2	Manpower Cost- (1) Sub Total:			54	$81,500,000	$8,150,000	$31,346
1.2.1	NACC Project Office		$150,000	10	$15,000,000	$1,500,000	$5,769
1.2.2	DMO - Other		$150,000	5	$7,500,000	$750,000	$2,885
1.2.3	RAAF HQ		$200,000	1	$2,000,000	$200,000	$769
1.2.4	Capability Group		$150,000	2	$3,000,000	$300,000	$1,154
1.2.5	DSTO		$150,000	30	$45,000,000	$4,500,000	$17,308
1.2.6	DITR		$150,000	2	$3,000,000	$300,000	$1,154
1.2.7	Dept of Finance and Admin		$150,000	2	$3,000,000	$300,000	$1,154
1.2.8	Professional Service Providers		$150,000	2	$3,000,000	$300,000	$1,154
1.3	Aggregate Overhead as % of Labour (2)			27%	$22,005,000	$2,200,500	$8,463
2.0	**PROJECTED EARNINGS**			**Sum**	**$107,142,857**	**$10,714,286**	**$41,209**
2.1	Industry Contracts (Gross Revenue) (3)	$500,000,000	$714,285,714	1	$714,285,714	$71,428,571	$274,725
2.2	EBITDA @ 15% (4)		$107,142,857	1	$107,142,857	$10,714,286	$41,209
3.0	**PROJECTED RETURN/(LOSS)**				**($210,647,857)**	**($21,064,786)**	**($81,018)**
4.0	**CURRENT EARNINGS**						
4.1	Contracts to Date (Gross Revenue) (5)	$60,000,000	$85,714,286	1	$85,714,286	$8,571,429	$32,967
4.2	EBITDA (@ 15%)	$9,000,000	$12,857,143	1	$12,857,143	$1,285,714	$4,945
5.0	**CURRENT RETURN/(LOSS)**				**($304,933,571)**	**($30,493,357)**	**($117,282)**

Simplified Analysis of Defence JSF SDD Business Case: Return through Industry Earnings Basis

Notes:
1. Estimates of total costs of employment.
2. Mid range estimate of overhead expressed as percentage of employment costs.
3. Based on advice provided in JSF Project Office Brief circa 2002 – "*on offer are between $300m to $500m worth of contracts in SDD/LRIP Phase*".
4. Earnings Before Interest, Tax, Depreciation and Amortisation – mid to high performance.
5. Department of Defence Answers to Question W6 on the JSF Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

Figure 7: *Simplified JSF Business Case.*

17. One of the reasons why Australia joined the SDD Phase of the JSF Program and, thus, had committed $US150 million dollars to the program was to have access to the project data. Therefore, Air Power Australia recommends a similar exercise to the above prudent costing approach be undertaken, using the JSF Program Office (USA) costing models as the costing basis along with the costing data on the Australian specific aspects from the NACC Project Office. A worthwhile thing to do then would be to compare the resulting figure with that determined in the funding model of the original Defence Business Case for the JSF, circa 2002.

18. On the Defence JSF SDD Business Case, a number of observations can be made and conclusions drawn. The principal one of these is that by any measure, the NACC-JSF Program is following a loss-lead business model of enormous proportions. That is, in addition to the acquisition program itself, significant investments are being made and losses are being allowed to accrue by Defence and other government departments as well as Industry. Like all applications of the loss-lead business model, the aim is for such investments and resulting accrued losses to be offset and then recovered (and, significantly so), by the benefits that should accrue from the project in which the investments are being made and the losses accrued, initially. Loss-lead business models are effective where significant initial investments are needed but commensurately large returns are assured due to such things as the generation of a strong, sustainable demand on the business and/or clear and unambiguous means for converting risks into opportunities that yield such returns. One needs to ask if Australia's involvement in the JSF Program meets the requisite criteria for application of such a model?

19. The table in Figure 7 is a simplified analysis, on a return through Industry earnings basis, of the JSF Business Case which relies upon the information presented by Defence in JSF briefings, media releases, and submissions to the Australian Parliament [8].

20. This simplified analysis does not include a number of related considerations such as the Business Development Budgets of Industry members who bid but are unsuccessful. The cost of bidding generally ranges between 1 per cent to 3 per cent of the gross value of the target contract. Therefore, over the ten year period, these costs could range from zero to $A20m+, depending on how successful and committed the bidders are in the project. Also, this analysis does not consider any benefits that may arise from the agreements on the financial provisions in the JSF SDD Memorandum of Understanding (MOU) since any such benefits would accrue after the 10 year period to which this analysis applies. That said, these benefits are briefly described and discussed at the end of this section.

21. Even with these limitations, this analysis clearly shows that, on a return from Industry earnings basis, the Defence JSF SDD Business Case was, at best, courageous and, on merit, far from compelling. To embark on a 10 year program that would result in a negative '*return on investment*' ratio let alone one that approaches a ratio of minus two would have required some heroic assumptions in its justification. To continue in the same vein some four years into the program when the empirical indicators show this ratio heading further south would be more than heroic. This is not to say participation in the JSF SDD should be terminated, though that is certainly one of several solution options. However, the full potential of this loss/lead business model would appear not to have been fully explored let alone canvassed as an option, particularly in the area of turning risks into opportunities where the means for

mitigating such risks are so inherent in Australia's unique assets, capabilities and people skilled in the aerospace and systems sciences and engineering. [9]

22. Returning to the JSF SDD MOU and the benefits that may arise from the agreements on the financial provisions. Senior defence officials have advised that -

"(viii) Australia obtains a range of benefits from its investment in the JSF program. These benefits include:

- *the unprecedented opportunity for Australia to participate in the development of an advanced fighter aircraft;*
- *the opportunity for Australian industry to be part of the global supply chain of the world's largest defence project;*
- *privileged access to JSF project information;*
- *priority for acquisition of the JSF aircraft; and*
- *guaranteed waiver of at least the SDD investment from Non-Recurring Engineering costs (guaranteed full waiver if Australia acquires aircraft through the Production, Support and Follow-on Development MOU, valued at as much as US$1 billion)."*

Department of Defence Answers to Question W6
JSF Development and Procurement, Pages 20 – 31,
Questions on Notice from the Supplementary
Budget Estimates Hearing of 02 November 2006.

<table>
<tr><th colspan="2">Value of contributions
Level III Partner</th><th>National deputy</th><th>JSF Program Office staff</th><th>Data use rights</th><th>Benefits during production</th></tr>
<tr><td rowspan="3">Australia•</td><td rowspan="3">U.S. target: approximately 1-2 percent or $250-500 million

Negotiated contribution: $150 million</td><td rowspan="3">Reports to the JSF international director</td><td rowspan="3">One integrated staff, who performs both national deputy duties and participates on the C4I IPT</td><td rowspan="3">Project purposes: includes use for the performance of project activities under SDD MOUs</td><td>Delivery priority based on level of SDD contributions</td></tr>
<tr><td>Consideration for waiver of all non-recurring research and development costs</td></tr>
<tr><td>Levies from sales to nonpartners based on level of SDD contributions</td></tr>
</table>

Australian Contributions and Benefits:
Extract from GAO Report No GAO-03-775

Figure 8: *Australian Contributions and Benefits: Extract from GAO Report No GAO-03-775*

23. Whereas, in a report titled, "Joint Strike Fighter Acquisition: Cooperative Program Needs Greater Oversight to Ensure Goals Are Met" dated 21 July 2003, the US Government Audit Office listed the contributions and benefits in the MOU for Australia's participation in the SDD Phase of the JSF Program as per Figure 8.

24. Clearly, some more work needs to be done and some discussions held in relation to the terminology, definitions and the language used to determine what really are the Australian contributions and, moreover, benefits as a Level III Partner in the SDD Phase of the JSF Program. For instance, the use of '*Non Recurring Engineering costs*' in place of the MOU wording of non recurring *'research and development costs'* could lead to some confusion, particularly as to which US DoD budget line any '*consideration for waiver*' may be drawn. Similarly, to what does the '*as much as US$1billion*' refer?

25. Finally, the JSF Program Office is reporting the milestone for Defense Acquisition Board approval into Full Rate Production (FRP) as currently scheduled for the first QTR of CY2014. Analysis in FY2004 dollars indicates that the Average Unit Procurement Cost (UPC) for a buy of 100 x JSF aircraft at the beginning of CY2014 could be in the order of $US100.0 million (FY2004). Estimating when delivery could start and at what rate is somewhat problematic but as a Level 3 Team Member, Australia is behind Italy, Netherlands, Turkey and, possibly, Canada in the priority pecking order for full rate production CTOL aircraft. Acquiring earlier build LRIP (low rate initial production) units has always been the intention of the Director, NACC Project Office. However, these units, traditionally, would cost more (≈$US110 million per unit) and require additional expenditure to upgrade to the full rate production configuration.

26. Analysis in FY2004 dollars indicates that the Average Unit Procurement Cost (UPC) across a buy of 55 x F-22A aircraft in 2010, at the end of the current planned production of 183 units, will be about $US126.0 million (FY2004 dollars). Since this would be at the end of the current USAF production run, delivery to Australia could be seamless, starting in 2010 at Aircraft #184 at a rate to be determined, but 20 to 25 per annum could be possible.

The funding model for the JSF as presented by the Defence Capability Plan and representations to the Parliament by senior defence officials is not viable because :-

1. Unit costs advised by Defence over the past four years (a range between $US40m to $US45m) and upon which these representations are based are only a part, in fact, less than half, of what will be the unit procurement cost if Australia were to decide to buy the JSF.
2. Omissions of fact, imprecise language, and the incorrect use of terminology and definitions go to the credit and integrity of the model, highlighting its flawed nature and lack of rigour.
3. Time value of money (TVM) considerations do not appear in any of the representations.
4. The loss-lead Defence Business Case for joining the JSF SDD Phase was so extreme and embodied such high risk as to be,at best, courageous and, on merit, factually unsupportable and non-executable to any positive effect in its current form.
5. The disciplines of risk assessment, risk management and T&E are notable by their absence.
6. The total procurement cost for a fleet of 55 x F-22A aircraft is estimated at $US6,930.0 million (FY2004 dollars) and delivery could begin in 2010 and possibly earlier, subject to how well Australia is able to negotiate on both price and delivery.
7. The total procurement cost for a fleet of 100 x JSF CTOL aircraft could range between $US10,000.0 million and $US11,000.0 million (FY2004 dollars) - more if the total build numbers for the USAF are reduced, or the Department of Navy build numbers are reduced, or the UK build order is less than 150, or one of the variants is cut, or the program schedule slips by more than a year, or other identified and as yet unidentified risks to the program materialise.

1.2 Why the F/A-18 HUG Funding Model is Not Viable

The principal reasons why the F/A-18 replacement schedule should still follow the guidance given in the Defence 2000 White Paper and occur in the 2010-12 timeframe (if not earlier) are the same reasons and supporting issues that make the F/A-18 Hornet Upgrade (HUG) Program Funding Model non viable.

The F/A-18 'Classic' is a third generation, short range, low capability category – or Tier 2 -tactical fighter approaching the end of its economic and useful strategic life. The latter is being hastened, and increasingly so, by the strategic developments in our Region, which can best be described as unprecedented proliferation of offensive and defensive weaponry in the high capability or Tier 1 category.

The HUG Program is a collection of system and weapon upgrades as well as Air Vehicle Modifications and refurbishment programs, the latter being to extend fleet airframe life from 2012 out to about 2015. The former are intended to upgrade and enhance the aircraft's air combat capabilities, endeavouring to address the growing imbalance in regional air superiority and the resulting threats. At the same time, these programs are intended to provide interim, albeit lesser, strike/ reconnaissance / surveillance / air vehicle interceptor / close air support capabilities in place of the F-111s which Defence has recommended to be retired early, in 2010, rather than in 2020 following guidance given in Defence 2000. The threat to Australia's long standing position in regional air superiority is further exacerbated by features peculiar to the F/A-18 'Classic', and the Australian variants, as well as the maintenance and operational doctrines that have been applied to them since their introduction in the 1980s.

It is well known that the RAAF's usage of the aircraft has been to meet the requirements of the fighter as well as the ground attack/close air support roles. The result has been the application, until relatively recently, of a demanding load spectrum on the aircraft, beyond the design spectrum during its earlier life – in the language of the common man, somewhat akin to exposure to greater wear and tear. Again until relatively recently, the maintenance philosophy applied to the aircraft did not include a deeper level maintenance cycle wherein the aircraft would have been 'overhauled' on a periodic basis. In fact, many of the maintenance activities now planned as part of the deeper level maintenance servicing activities being done in association with HUG will be performed for the first time in the aircraft's life. Access will be gained and inspections will be carried out in areas on the aircraft that have not seen the light of day since original manufacture back in the 1980s. Structurally and, to a lesser extent, from an Air Vehicle Systems perspective, the RAAF fleet of Hornets is made up of two build standards, having been produced on two quite separate production lines with different production philosophies and standards. This history, variability and life cycle experiences are now making their presence known, as the HUG and deeper level maintenance activities proceed.

Effects due to Structural Refurbishment Programs. The significance of this is now becoming apparent with the implementation of the structural refurbishment program (SRP) associated with the HUG and the deeper level maintenance servicings. The primary basis of the SRP was the International Follow On Structural Test Program (IFOSTP) Program and the related Airframe Life Extension Program (ALEXP). These programs involved full scale fatigue analyses and testing being carried out on a limited number of test articles, though this is the norm because of the time and expense to do such work. These programs generated many hundreds of inspections and related repair techniques along with life extending modifications to the structure of the F/A-18 air vehicle. From their origins and, thus, statistically, these 'refurbishment' activities are based upon a fairly small sample of the F/A-18 'Classic' fleet. Though attempts have been made to generalise the activities for the range of aircraft, their applicability, relevance, and ability to capture all structural defects/issues before they become a problem are influenced by a large number of variables, including variations in aircraft configurations and build standards. As a result, the number of refurbishment activities needing to be applied to the RAAF fleet is increasing, the deeper and further the maintenance teams are now getting into the now multiple structural repair programs – SRP-1, SRP-1A, etc.

Effects due to Fuel System. The absence of a deeper level maintenance program for the bulk of the now extended life of the aircraft means that the fuel bladders, which have a finite life of around 17 to 20 years, are now perishing and in need of replacement. Attempts to repair such bladders are in vain, due to their deteriorated state and the damage that ensues in removal and replacement activities required in effecting any repairs. The fuel leaks on the F/A-18 aircraft appear to be worse than those observed arising on the F-111s back in the 1970s, prior to the introduction of the Deseal/Reseal Program.

Effects due to Surface Finish and Corrosion Protection Systems. In the main, the aircraft have not had their surface finish completely replaced at any time over their life. Progressive and more extensive repairs and more expansive refurbishment activities have been the norm. Experience suggests that complete stripping back to parent metal, complete repair, repriming and a full repaint will be required on the bulk, if not all, of the fleet. This is neither a trivial or non-hazardous task from the perspective of cost, time, scheduling, manpower, OH&S and environmental considerations.

Effects due to Corrosion and Deterioration Related Defect Accrual. The absence of a deeper level maintenance program means there are areas on the aircraft that have not been subject to regular inspections or been inspected at all (eg. wing skin faying surfaces, internal bulkheads, etc.). As a result, there is a medium to high probability of there being corrosion and/or other deterioration related defects in these areas. It would be reasonable and, given flagging of these possibilities earlier this decade, likely that the extent and consequences of any such defects are in the process of being determined through statistical sampling inspection methods in order to ascertain the extent/pattern of any such problems across the fleet.

Effects due to Electrical Wiring and Associated Looms. Kapton insulated wiring was used extensively in the manufacture of the RAAF F/A-18s. This wiring is particularly susceptible to age related deterioration and embrittlement of a form that has been known to cause wiring failures, arcing and fires, both whilst the aircraft is airborne and on the ground. Kapton has been implicated in several catastrophic losses of commercial airliners as well as military aircraft. On balance, there are mitigators to these effects that go to the way the wires are installed, supported and maintained overall. However, this is a particularly insidious age and operational environment related problem. Since the late 1980s, after much lobbying by experts both in and outside the organisations, an increasing number of operators and manufacturers around the world have banned its use in later build aircraft and in repairs/modifications to existing systems that use Kapton insulated wire. In fact, the Australian Directorate General of Technical Airworthiness (DGTA) in the 1990s was one of the few airworthiness regulatory authorities to have done so. The US Navy banned the use of Kapton back in 1988. The aim here is not to inflame or sensationalise what, in aerospace engineering circles, is now a well-known material hazard condition. The aim is to provide sufficient background to enable the following issue on the RAAF F/A-18s to be properly aired and appreciated.

This particular problem is aggravated by mechanical disturbance of individual wires and wiring looms as will happen in many of the modifications and structural inspections/repairs to be undertaken as part of the HUG and deeper level maintenance programs on the RAAF Hornets. This will especially be the case with the Fuselage Centre Barrel Replacement Program currently planned, since complete looms (some of which have lay undisturbed in the airframe since manufacture), will be required to be demounted and folded back out of the way. The prudent (though costly and time consuming) approach would be to replace all the Kapton insulated wiring in the aircraft since the integrity of the insulation can start to progressively and increasingly break down after about 15 years in service. Anecdotal evidence of this occurring can be seen in the increased amount of time being taken to effect electrical inspections, servicings and repairs during both scheduled and non-scheduled maintenance activities on the aircraft. Lead aircraft in the RAAF fleet are coming up to 25 years service. Fortunately, informal advice indicates that, from an ongoing maintenance cost and, ultimately, safety perspective, replacement action is finally being considered if not already determined in the affirmative. If true, this is welcome news, safety wise, but the likely timing should further bring into sharp relief the false economies in the reversal of the Defence 2000 White Paper guidance.

A footnote to the Bravo Zulu (aka Bouquet) for DGTA. Interestingly, but not surprising to those who know Defence today and how decisions are made today, recent selections of aircraft with projected lives well beyond 25 years contain Kapton insulated wiring. This is reminiscent of some other (in)famous Augustine sayings that would be apt to ponder while waiting for the responses, having asked the question, "Why?". [10]

Effects due to Risk Assessments and Risk Management.

In response to the questions -

(ii) What are the prerequisite projects associated with the Hornet upgrade?

(iii) In standard risk assessment terms such as those used in AS/NZS 4360:2004, what are the statistical probabilities for each of these projects being completed on schedule? What is the overall statistical probability that all these projects will be completed on schedule?

provided on notice by the Senate, following the Supplementary Budget Estimates Hearing on 02 November 2005, senior defence officials had this to say –

(ii) The prerequisite projects associated with the Hornet upgrade include the sub-elements of Air 5376 Hornet Upgrade (Helmet Mounted Cuing System, Link 16, Electronic Warfare Self Protection, and Structural Refurbishment), improvements to the Hornet's strike capability provided by Air 5409 Bomb Improvement Program and Air 5418 Follow On Stand-Off Weapon. The Chief of Air Force was also referring to the prerequisite elements of the air combat environment in which the Hornet

will operate such as B737 Airborne Early Warning and Control aircraft and the extended operating range provided by A330 air-to-air refuelling aircraft.

(iii) An understanding of risk is an integral part of Defence's management of upgrade and acquisition programs. Risk to schedule is one element of any project's overall risk profile and a schedule risk for each project is determined and treatments applied. Defence uses a combination of qualitative and quantitative measures to manage risk.

This exchange brings into focus two very important aspects that are fundamental to the disciplines of risk assessment and risk management, and provides a useful insight into the way that senior defence officials think about risk.

Importantly, the number, size and nature of the sources of risk must first be identified, along with the risks inherent in these sources, as the front end of the risk assessment. At this point, it is useful to organise the sources of risk into a form that considers and reflects the interrelationships between the sources and the risks they bring to the project. Where there are a number of activities that, for organisational, managerial, funding or other reasons, are separate in their own right but are interrelated through risk, a prudent and normal approach is to bring them under the purview of a master program – oftentimes referred to as a Capstone Program.

Secondly, the number, size and nature of the sources of risk need to be quantified, as do the risks themselves. This may be achieved through the application of various techniques that are intrinsic to the risk assessment discipline. The aim is for the sources of risks and the risks themselves to be 'objectified' to remove the inherent risk that ethereal subjectivity brings to risk management and the achievement of effective decision making. Flowery hyperbole and the wearing of rose coloured glasses (and not much else) have no place in the worlds of risk assessment and risk management.

Turning back to the exchange above. The first response lists out quite a number of projects which, within themselves, are quite complicated and challenging. The response states that they are interrelated and, moreover, there are other larger and more complex "*prerequisite elements of the air combat environment*" to which these projects are related. The response identifies some 8 projects that are interrelated but gives no indication as to how these interrelationships are to be managed. Common sense says that if these projects were being managed via an overarching process, such as a Capstone Program, this would be in the planning documents (eg. Defence Capability Plan) and would have formed part of this response, if for no other reason than for such approaches to be effective, they require resourcing and funding. Also, the response does not identify any of the other interrelated sources of risk, such as those outlined above.

The second response is 'flowery hyperbole' and indicates either a complete lack of understanding of the question or of the risk assessment discipline itself.

A simple and appropriate answer would have been to state the probability that has been calculated for each project to be completed within its planned schedule. This is a relatively simple thing to do. To answer the second part of the question, this is simply done by applying the product rule of probabilities[11] .

For example, the schedule risk for one of the projects may turn out to have a probability of success of $P_s = 0.93$. In other words, it has been determined through analysis of the risks that can effect schedule, that there is a 93% probability the project will be completed on time. For a complex aerospace project, this would be a good result from a robust risk analysis, particularly if this is the probability of successful completion on time that is determined at the start of the project. To give the reader some feel for what this means, the target Key Performance Parameter for reliability (ie. probability the aircraft will be available to fly) of the CTOL JSF is 93%.

If the final outcome that is being sought, say the early retirement of the F-111s, is dependent on all the projects being completed on time, then the probability of this being achieved is simply P_s^N where N is the number of projects. At this point, we don't have the probability for successful completion for any of the eight (8) project advised by Defence. However, to get some indication, a conservative approach would be to apply the above P_s of 0.93, since this would be a quite a good result for a robust risk analysis of any complex project. Taking this approach yields –

$$P_s^N = 0.93^8 = 0.56$$

What this is saying is that the probability of all eight projects which each have probabilities of successfully meeting their schedules of 93%, being completed on time is 56%.

This simple calculation, along with the above exchange and discussion, also permits several other observations to be made. Firstly, the senior defence official/s who provided the response to the question from the Senate Committee does/do not understand the risk assessment discipline and, therefore, the claims made in the second part of the response are not credible. Secondly, the probability of successful achievement of the plans being made by senior defence officials is low and these plans are high risk. Thirdly, in order to mitigate these risks and achieving the desired outcomes within the time that has been set, significant resources and funds will be needed to improve and manage the inherent risk profile. The resources required to achieve the desired outcomes will have to include requisite expert skills and competencies in risk assessment, risk management, and T&E (Test and Evaluation).

Effects due to Schedules and Co-ordination of Works.

Between now and 2010, there are four years in which, under the plans of senior defence officials, the F/A-18 fleet must undergo an extensive amount of work. Some elements of this work are mutually exclusive of each other and, therefore, cannot be undertaken together on the aircraft at the same time; some need other elements done before they can proceed; some are dependent on work currently being done overseas; some are dependent on long lead time parts from overseas; some take a long time per aircraft; and, all are dependent on the availability of manpower, facilities and specialised equipment.

For example, the requirements for doing the Fuselage Centre Barrel Replacement (CBR) include a large special jig, a big replacement part from overseas (the fuselage centre barrel itself) and a multiplicity of other parts. In addition to these, there are the requirements for special tooling, about 10 calendar months to complete with the aircraft spending much of this time in the special jig, specially trained personnel, and a mountain of paper work to be gone through by a large number of people.

The level of effort required to plan and then co-ordinate and do the CBR modification is significant, in itself. But when the planning, co-ordinating and doing for CBR and all the other work that must be done to meet the plans of the senior defence officials in Canberra must happen in the same four year time window, this is challenging. However, when this planning, co-ordinating and doing has to consider, as it must, all the other work that will arise as a result of the condition of the fleet and the embryonic deeper level maintenance program, the effort and resources to do so effectively, in such a timeframe, are huge.

This incurs a high risk and will add significantly to the overall costs of the HUG Program in order to properly mitigate this risk– far more so if the funds and resources are not made available to effectively (and quickly) plan, then co-ordinate and do the work.

Effects due to Aircraft Availability.

While all this work is being done on the aircraft, there is something that is not happening as a result. The aircraft are on the ground. They are either in maintenance or being prepared and waiting to go into maintenance, or in the process of being released from maintenance and being prepared to return to service. Irrespective of where they are in this program, the aircraft are not flying and, moreover, are not available to fly.

This is one of the more insidious but less talked about outcomes of such a large grouping of maintenance activities – upgrades, first time deeper level maintenance servicings, structural refurbishment programs, corrosion repairs, fuel bladder replacements, repaints, rewirings, rectification of known defects, and allowing for unscheduled arisings – in such a relatively short time window. To perform all the work that is required on the fleet of 71 F/A-18 aircraft in the remaining four years, to meet the expectations of Canberra, will mean that aircraft availability will drop and remain low for the duration of these activities. Only seeing aircraft availability numbers in the mid to low teens, for extended periods of time, over the next four to six years is a real possibility. If this is allowed to become a reality, given the now considered normal happenings on RAAF F/A-18 flight lines, it would be hard to see how one could muster a five ship fly past, let alone be in a position to defend our Nation.

Senior defence officials have recently started talking publicly about the cost of not having a capability available. However, much of this talk is ethereal and highly subjective. There is a real cost that results from reduced aircraft availability and this needs to be measured by Defence and added to the HUG Funding Model. This cost is significant and, moreover, has far reaching and long term negative effects on defence capabilities.

Effects due to Costs.

Put simply, costs will be increasing and the probability of them continuing to increase is high to very high, and markedly so. This will become particularly obvious when the actual and complete costs of the HUG, deeper level maintenance, structural and other Air Vehicle repairs and refurbishments, operational level maintenance, unscheduled maintenance arisings, and engine sustainment are compiled and reported on a project basis, including the largest of all costs, manpower. The latter is rarely, if ever, reported in a way that allows costing attributions to be derived directly for the purposes of risk management, performance measurement and just good project management. Presently, cost reporting to the Parliament takes the form of a 'vanilla' and 'omnibus' manner. In relation to F/A-18 fleet costs, in the reports to Parliament such as the Defence Annual Report, these are rolled up with the costs of the F-111, Hawk and PC9 fleets and presented as an aggregate under the Air Combat Capability Group. The fiduciary performance of the directing and oversight levels of governance of the Department of Defence is being severely constrained and hampered by this method and form of reporting. It hasn't always been this way. [12]

Effects due to Primary Justification for Defence Reversal of White Paper Guidance.

As to whether the consequences for transparency that arise from the method and form of reporting discussed above are intentional or just an inadvertent outcome of short sighted or unthinking adherence to process is for others to determine. Certainly, our Government's Policy is one of declared openness and transparency – open government is the term that is commonly used - so it would be rather foolish, to say the least, of senior defence officials to intentionally breach Government Policy.

In not dissimilar circumstances, one needs to question senior defence officials' strident recommendations to the Government back in the 2001 to 2003 timeframe to cease the evaluations for Australia's new air combat capability under Air Project 6000 and effectively commit significant resources to the JSF. Similarly, their equally strident recommendations to retire the F-111 fleet early, before the F/A-18s. Both sets of recommendations effectively reversed the guidance in the publicly consulted Defence 2000 White Paper. The early retirement of the F-111s was being justified on the basis of occurrences that have been subsequently shown to have been problems incorrectly attributed to the aircraft and claims that persist today[13] that "*the [high] cost of maintaining that advantage (the F-111s) is distorting the shape of the force*"[14].

This claim was robustly challenged and roundly debunked back in 2005 without counter challenge or rebuttal from senior defence officials except within the secretive cloisters of Russell Offices where it would appear that blame is the game and groupthink dominates. The absence of any objective or constructive response was disappointing. The analysis [15] was openly and traceably based on Defence statutory reports and statements of senior defence officials responsible for the capabilities to which the analysis of costs and cost projections referred and had been previously provided. This was done in the spirit of continuous improvement and in response to the requests for feedback as may be found in the Defence Service Charter and the public pronouncements of these same senior defence officials.

The above series of effects on the viability of the HUG Funding Model should have encouraged even the most sceptical among us to ask, "Could it be that what the senior defence officials are planning for our future security and that of our children be less than optimal?". If further encouragement/enlightenment is needed, then read the following points and advice –

1. The RAAF Air Combat Capability Paper to the Joint Standing Committee on Foreign Affairs, Defence and Trade on 04 June 2004 states in Figure 2, titled 'F-111 Cost of Ownership –

Cash' that the total cost to operate, maintain, and upgrade the F-111 out to 2020, in keeping with the White Paper guidance, would be between $A2,500 and A$3,500, including personnel costs. However, the cashflow graph shows the total amount to be expended over the period 2004 to 2020 to be $A3,976.1 million. Discounting this cash flow back to 2004 on a present value (PV) basis yields a comparative PV figure of $A2,224.5 million in 2004 dollars.

2. The Defence Capability Plan (DCP) 2004-14 shows the budgetary estimates for the 'pre-requisite projects associated with the Hornet Upgrade (HUG)'. The aggregate of these, including Air 5418 – Follow On Stand Off Weapon and the Bomb Improvement Program, is A$2,725.0 million. This is for the capability upgrade acquisition projects, only. It does not include the costs for the preceding 'effects' nor the costs for operating and maintaining the fleet out to 2015 which is the life extension on the F/A-18s to be achieved through the HUG Program (as opposed to 2020 for the above F-111 costs). Presumably, though not clear, this figure does not include personnel costs – certainly not those for operating and maintaining the Hornet fleet nor for the 'effects'. Assuming, in the best case, that this figure is not as it would appear, namely, in 2004 dollars but actually the aggregate of the cash flows over the period in then year dollars. Then, using the schedule time lines in the DCP and applying the same present value discount factors (as for the F-111 analysis) yields a comparative PV figure of $A2,137.7 million in 2004 dollars.

3. A conservative estimate of F/A-18 operating and maintenance costs out to 2015, in PV 2004 dollars (for comparative purposes) would be $A3,002.7 million. Adding this to the capital costs for the HUG and associated upgrades and comparing this with the F-111 costs advised by the RAAF yields the following comparison in PV 2004 dollars –

Cost Capability Improvements and Related Savings

F/A-18 Fleet : Total Ownership Cost (Almost*) to 2015 $A3,002.7 million + $A2,137.7 million =	$A5,140.4 million
* Does not include costs of 'effects' et al that will be funded through Minor Item Submissions (MIS) and running system budgets.	
F-111 Total Ownership Cost of F-111 Fleet out to 2020	$A2,224.5 million
<u>Result:</u> 15 more years of long range strike capability plus savings of	$A2,915.9 million

4. In 2005, letters to the now Chief of Defence Force, ACM Angus Houston and the Chief of Capability Group, LtGen David Hurley, outlined the Industry Proposals of 2001/02 provided to senior defence officials in response to the requests from Defence for 'innovative, cost effective solutions to Australia's air combat capability needs' along with a way for implementing these proposals and saving the Australia tax payer over $A4,500 million dollars. A true 'win-win' outcome.

The funding model for the HUG Program as presented by the Defence Capability Plan and representations to the Parliament by senior defence officials is not viable because :-

1. The original model and business case failed to consider the effects of a considerable number of features unique to the Australian F/A-18 aircraft which have a significant negative impact on the cost, schedule and risks of the program.
2. The objective disciplines of risk assessment, risk management and T&E are notable by their absence.
3. The funding model does not consider the largest cost of all - being personnel costs.
4. In financial terms, the primary justification for the program was and continues to be seriously flawed.
5. Time value of money (TVM) considerations do not appear in any of the representations.
6. Senior defence officials had and continue to ignore the advice of independent experts and do so with prejudice to the experts, to the Parliament, and to the Nation, as well as their own credibility and the reputation of the Department of Defence.

1.3 Defining a Better Alternative

The following extract is from one of the letters referred to in the previous discussion:

"We are hopeful that you, along with the experts on your capability staff, will be prepared to engage us in discussions on the air combat capability options available under the force mix option entitled "The Evolved F-111".

This option was developed by members of the Defence Industry and provided to the Air 6000 Project Office in response to their Force Mix Option Market Survey 'Request for Proposals' run in the latter part of 2001. Following the Project Office's expressed interest in this option at a meeting in Adelaide in early 2002 and stated intention to recommend "The Evolved F-111 Option" for inclusion in Stage 3 of Air 6000, more detailed information and data were provided in the form of Unsolicited Proposals from Industry (UPIs). These UPIs were submitted to the Undersecretary of Defence Materiel (USDM) in accordance with the procedures in the Capability Systems Life Cycle Management Guide/Manual applicable at the time. Additional copies were provided to applicable stakeholders, including Industry Division of the DMO. These UPIs were also provided to the then newly formed UPI Desk within DMO Industry Division following Minister Peter Reith's policy statement on Unsolicited Proposals from Industry at the Defence/Industry Conference the previous year in June 2001.

As predicted and derived from the studies undertaken in the development of these Proposals, the 'Evolved F-111 Option' (aka: 'Enabling Cost Effective Acquisition of the F/A-22A Capability') offers unparalleled innovative benefits for Defence, the Australian Defence Industry and Australians as a whole, including –

1. *A far superior air combat capability and associated force structure than any other option presently available or considered; made up of the Raptor's air dominance and first day strike capabilities embodied in 50 platforms, complemented by the long range strike, reconnaissance/surveillance, battlefield airborne interdiction and close air support capabilities of 36 Evolved F-111s.*

2. *Opportunity to purchase fifty (50) F/A-22A Raptor aircraft systems plus five (5) attrition aircraft, at a later date, for somewhat less than $A10bn or; looking at this another way, more than $A3.5bn less than the median budget ($A13.5bn) provisions in the DCP for the NACC/AIR 6000 Project.*

3. *Ability to acquire this capability prior to 2010, thus avoiding any capability gap by filling it with an air dominance strike fighter capability and negating the need for doing expensive modifications to the F/A-18s which, if undertaken, would see F/A-18 availability fall to an all time low.*

4. *Total avoidance of the risks arising from dependence on a single product and general monopoly supplier situation that arises from a single aircraft type replacement strategy. (I refer you to the experiences that operators of the Chinook CH-47 helicopter are currently having with the resupply of such items as main transmission gear boxes.)*

5. *Negates the need to spend upwards of an additional $A10bn more to transition a lesser air strike capability onto the F/A-18s and keep them flying till 2015 than if the more capable air strike capability of the F-111 were realised, retained and progressively developed through to 2020+. Such development can be done in Australia by Australian Industry. This, in turn, provides additional benefits in relation to Industry capability development and the economy (ie. balance of trade, etc.) which would be further enhanced by remaining in the JSF Program for the longer term options it could present while helping retire JSF program risks using assets unique to Australia.*

Note: We would be happy to provide you with the basis and results of this analysis for you to have our work independently checked. FYI, the figures on which this analysis is based come from the Department's statutory financials, Defence Annual Reports, and departmental submissions to the Parliament. Like all these things, the actual analysis is a relatively simple, straight forward present value model used for comparing the cash flow profiles of projects over a given time line (in this case 2004 to 2015) on a TVM basis. In essence, this is the type of analysis that Dr Stephen Gumley alluded to when he pondered the question of the value of accrual accounting in Defence in his recent address entitled, 'Poacher turned gamekeeper'.

These and the other top ten reasons/benefits/advantages for considering the "Evolved F-111 Option" may be found on the Air Power Australia web site (www.ausairpower.net) on the Frequently Asked Questions page with further details contained in the relevant sections of the web site and on-line journal.

An executed copy of this E-Letter is attached and we look forward, with great interest, to your response and the opportunity to discuss, in detail, what has been proposed in keeping with Defence's entreaties to Industry "....... to come up with innovative, cost effective solutions for Australia's defence capability needs"."

In May, 1998, one of the authors of this document submitted a proposal to the then Minister for Defence, which identified deep and fundamental shifts in the character and scale of regional air power, largely arising from the influx of significant numbers of Russian Sukhoi fighters and supporting assets. This issue is discussed in detail in Section 2 of this submission. The key conclusion within the study that underpinned this proposal was that the only viable long term choice for replacing Australia's F/A-18A fleet was the new F-22A Raptor, for strategic, operational and technical reasons. Another conclusion was that the Joint Strike Fighter was not suitable for the air combat role, and would at best be viable as a strike oriented supplement to the much more capable F-22A.

This study was followed by a research effort in late 1999, which explored requirements for aerial refuelling capability to enhance RAAF capabilities, and provide the ability to robustly defend the sea air gap. This research resulted in a monograph on aerial refuelling published by the RAAF early in 2000, and a companion document later submitted to the office of the then Minister for Defence. Key conclusions of this analytical research were that low capability or Tier 2 category fighters demanded prohibitive amounts of aerial refuelling support to perform adequately in Australia's geography, that heavy aerial refuelling tankers, especially derivatives of the Boeing 747, were preferable for economic, flexibility and capability reasons, and that the F-111's prodigious range and payload capability resulted in significantly lower operational costs in combat, due to reduced demand for expensive aerial refuelling.

By 2000, increasingly, reports from the DSTO F-111 Sole Operator Program (SOP) indicated that the aircraft had significant potential for life extension, at modest cost, beyond the previously accepted target retirement date of 2020. This opened up the opportunity to emulate the US Air Force strategy of economical bomber life extension, which is likely to see aircraft of similar construction ages and airframe technology to the F-111 operated until 2035, or later[16].

The two critical conclusions, in the terms of the RAAF fighter fleet, were that the F-22A was without doubt the best choice for the RAAF's F/A-18A replacement, and that long term retention of the F-111 would yield a significant payoff in capability, reduced aerial refuelling demand, and deferred cost of replacement with new aircraft.

This resulted in a series of engineering studies which explored specific upgrades to the F-111 intended to extend its service life, enhance its capability and reduce its long term operating costs.

The analysis at that stage was unambiguous – replacement of the F/A-18A with the F-22A would provide a decisive capability edge for decades, across the region, at low risk, and retention of an extensively upgraded F-111 would yield such savings in the acquisition budget, compared to a buy of even 100 low capability or Tier 2 new fighters, that any cost premium in the acquisition of the F-22A, and additional tanker aircraft, could be completely offset.

In 2001 an Australian Industry team was formed, and it submitted the 'Evolved F-111 Project' as an option to the AIR 6000 Force Mix Survey. This project proposed the acquisition of a force mix with up to 55 F-22A Raptors to replace the F/A-18A, extensive but low risk incremental upgrades to extend the life of the F-111, and acquisition of further mothballed surplus F-111s to enhance fleet strength. The model was designed to minimise risk, minimise 'spikes' in the acquisition budget, minimise balance of payments excursions, enhance Australian industry capabilities in key areas and provide a better capability per dollar, than any alternative.

The proposal became a shortlist contender during Stage 2 of the AIR 6000 evaluation, on its technical and strategic merit. It remains the most capable of any of the proposals devised to date for replacement of the existing RAAF fighter fleet.

The decision by the Defence leadership, in mid 2002, to effectively suspend AIR 6000 in favour of a single type Joint Strike fighter solution, was seen as peculiar, since the capability, risk and cost advantages of the F-22A/F-111 force mix proposal were compelling, and well understood due to the greater maturity of these programs, compared to the Joint Strike Fighter program.

Since 2002, evolving developments in the US, Australia and the region have strengthened the case for the F-22A/F-111 force mix model, and critically weakened any case which may have existed in 2002 for a single type Joint Strike Fighter solution.

Specific capability arguments for the F-22A are further detailed in Section 1.4, with supporting material in Annex A. Specific adverse consequences arising from early F-111 retirement are detailed

Proposal Metric	Australian Industry Solution (2001) Score	Current Defence Plan Score
Combat Capability Subtotal	+2	-10
Supersonic Cruise	0	-2
All Aspect Stealth	-1	-1
Phased Array Radar	0	-1
Internal Weapons 2 klb	0	-2
Max External Payload	+1	0
Int Weapons Payload	+1	-1
Combat Radius (Int Fuel)	0	-2
Cost Metrics Subtotal	+2	-6
Acquisition Cost	+1	-2
Acquisition Model	+1	-2
Life Cycle Costs	+1	-1
Return on Investment	0	-1
Risk Metrics Subtotal	+3	-13
Acquisition Risk	0	-2
Cost Risk	0	-2
Design Risk	0	-1
Strategic Risk	0	-1
Strike Capability Gap	+1	-2
Air Sup Capability Gap	+1	-2
Air Def Capability Gap	+1	-2
Net Assessment	+7	-29

Table 2: Summary table of assessment scoring for current defence NACC and interim planning against the 2001 Australian Industry solution. If a metric is met, the score is not incremented, if a metric is exceeded, the score is incremented by +1, if a metric is not met, the score is decremented by 1. The scores for the 'Current Defence Plan' aggregate the interim plan (2010-2018) and the NACC (2018 onward). Refer Annex B for detailed table (Authors).

in Annex D.

The F-22A/F-111 force mix model was designed to maximise capability per invested dollar, and involves using both aircraft types to exploit their strengths. The F-22A would be used to defeat opposing fighters, but also to penetrate heavy defences to bomb critical targets. The upgraded F-111 would retain most of its existing roles, but cede penetration to heavily defended targets to the F-22A. An additional role for the F-111 would be cruise missile defence, part of the original definition of the aircraft during the 1960s[17].

In practical terms the F-22A/F-111 force mix model uses both types as 'multirole' fighters, but uses the F-22A where the most capable threats are confronted, and the F-111 where its exceptional range and endurance are vital.

Proponents of the Joint Strike Fighter have argued extensively, in public and within Defence, that a single type solution based on the Joint Strike Fighter and an interim capability using the F/A-18A HUG, is an 'affordable' solution and one which is devoid of large risks due to the intention to build over 3000 Joint Strike Fighters.

There is no evidence to support any of these claims, and as the preceding analysis shows very clearly, the solution devised and adopted by Defence represents a very high risk and expensive solution.

It is illustrative to compare the solution planned for by Defence, using the F/A-18A HUG as an interim capability, and the Joint Strike Fighter as a long term capability, against the Australian Industry solution based on a force mix of F-22A and F-111 aircraft.

This comparative analysis was initially performed in 2001, and refined and updated annually since then. Table 2 summarises this analysis, using a broad spectrum of key metrics in the three categories of capability, cost and risk.

This analysis could be described as damning, insofar as in each category, and in the aggregate, the solution planned for by Defence is decisively inferior, despite the use of an analytical technique which effectively favours the Defence solution. In practical terms, Defence would like the Australian community to accept an inferior solution at a higher total cost and risk.

The difficulties in capability and cost observed in a basic but broad parametric analysis of the solution being pursued by Defence are also observed when other analytical modelling techniques are applied.

One such technique, used frequently by US entities such as the US Air Force or Defense Science Board, is to model 'operational economics'. This modelling technique is intended to look at the whole spectrum of operational costs incurred by a solution, in delivering its capabilities. As a result, hidden costs are exposed[18].

Air Power Australia performed such modelling initially in 2004, and revised and expanded the model in 2005.

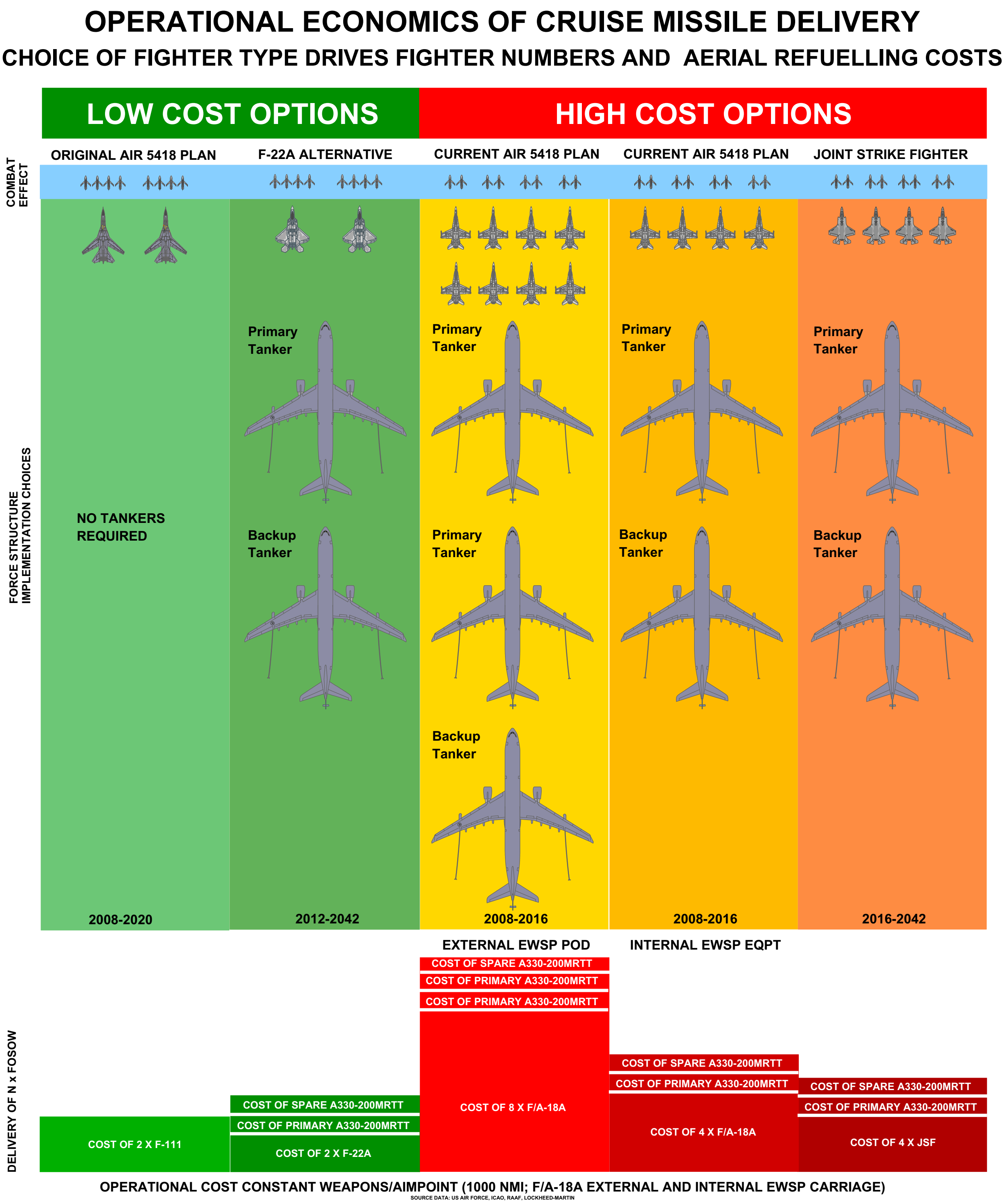

Figure 9: *The Joint Strike Fighter and F/A-18A are not operationally economical alternatives to the F-111 in the delivery of smart weapons, especially cruise missiles. This chart compares the delivery cost making the assumption that the F/A-18A can carry two cruise missiles and uses internal electronic countermeasures, or one cruise missile and external electronic countermeasures equipment (C. Kopp).*

The aim of this specific model was to look at the total cost in deployed aircraft to deliver eight AGM-158 JASSM cruise missiles to a target at a range of around 1,000 nautical miles. This is the same capability target used by Defence in the 2003 'blood chart' briefing, intended to justify early retirement of the F-111.

Applying publicly available unclassified performance figures and weapon payload figures indicates that the F/A-18A and Joint Strike Fighter incur significantly higher operational costs in numbers of deployed fighter aircraft, and numbers of supporting aerial refuelling tankers, compared to the F-111 and the F-22A.

Any incremental advantages the F/A-18A or Joint Strike Fighter might enjoy over the F-22A and F-111 in hourly operating costs are dwarfed by the significant hourly operating costs of the additional aerial refuelling aircraft required to simply get them close enough to their targets to launch weapons. If the distance to the target is increased further, these additional costs grow further. Refer Figure 9.

The commonsense reality and the mathematics of hard analysis agree completely. Small low capability or Tier 2 fighters like the F/A-18A and Joint Strike Fighter present false economies as they incur significant costs in supporting assets to match the inherent capabilities of large high capability or Tier 1 fighters, like the F-22A and F-111, and more low capability fighters, and thus crews, must be used to achieve the same combat effect.

The arguments via which such false economies are justified invariably revolve around concealing the additional costs in required numbers of fighters and supporting assets, and then arguing that the smaller less capable aircraft is 'cheaper to buy and run, therefore it is a cheaper solution'.

With a background of analytical studies spanning an eight year period, the Australian Industry solution based on the force mix of F-22A and F-111 is well understood, mature, and has been studied extensively from a multiplicity of perspectives.

As an alternative strategy for the replacement of the RAAF's existing fighter fleet, since it was conceived in 2000, the F-22A/F-111 force mix has become cheaper to acquire, due to cost creep in the Joint Strike Fighter over the last three years, and its capability advantages have grown as the US Air Force incrementally added capabilities to the F-22A, while Joint Strike Fighter performance was traded down to comply with CAIV objectives chasing a target production cost.

There are compelling budgetary, risk, timeline and industrial base reasons which favour the F-22A/F-111 force mix model over the single type model, using the F/A-18A HUG as an interim capability and the Joint Strike Fighter as a long term capability, regardless of the superior capability of the F-22A/F-111 force. Even if capability and strategic issues are to be regarded as less important than budgets, risks, timelines and industrial base capabilities, which they are not, then analysis decisively favours the F-22A/F-111 force mix.

1. In 2001 an Australian Industry team submitted a proposal for an F-22A/F-111 force mix as an alternative to the AIR 6000 force mix survey. This proposal was shortlisted in 2002 for further evaluation.

2. The F-22A/F-111 force mix is cheaper to implement than the plan devised by Defence, as only the F/A-18As need to be replaced with new fighters, and the existing investment in the F-111 and its extensive support base is exploited fully. There is no need to make extensive investments in the F/A-18A and incur the resulting poor return on investment.

3. The F-22A/F-111 force mix represents much lower risks in implementation since only the F/A-18A is being replaced, while the replacement F-22A is a now mature operational fighter in full rate production. The risks in extending the life of the F-111 are low, and well understood due to the extensive taxpayer investment in the Sole Operator Program.

4. The F-22A/F-111 force mix permits earlier replacement of the F/A-18As using the F-22A, with highly predictable timelines and acquisition costs.

5. The F-22A/F-111 force mix offers a more predictable expenditure profile, with a large block outlay only associated with the acquisition of the F-22A. Life extension upgrades on the F-111 permit scheduling of expenditures over an extended period, in small increments to address specific block upgrades.

6. The F-22A/F-111 force mix retains the extensive avionic systems integration and support expertise inherent in the current Amberley F-111 support base. This national asset is otherwise destroyed, should the strategy espoused by Defence be pursued.

7. The F-22A/F-111 force mix incurs significantly lower strategic and political risks than the strategy espoused by Defence. This is because the F-22A is and will remain the most capable fighter in the market, and its costs are known and predictable, while the F-111 is a well established and well understood capability in this region.

1.4 Why the F-22A to Replace the F/A-18A?

The F-22A is a revolutionary aircraft, with key capabilities possessed by no alternative, making it also unique.

Figure 10: *The F-22A is now in full rate production, and operational service with the US Air Force. The depicted aircraft belongs to the 27th Fighter Squadron based at Langley, Virginia, and was photographed in mid 2005 (US Air Force).*

It is the only combat aircraft in existence, and planned, which combines high stealth capability with supersonic cruise capability.

Stealth capability amounts to the ability to defeat opposing sensors, especially radar, thus effecting surprise in combat. Like all defensive capabilities, stealth performance varies widely across fighter types. At this time the F-22 has the best stealth performance of any high performance fighter in existence, or planned.

This kind of stealth capability has to be designed into an aircraft from the outset and cannot be added by upgrades.

Supersonic cruise capability is the ability to maintain supersonic speeds without the use of engine afterburners. Afterburners will burn a fighter's fuel many times faster than its engines burn fuel without the afterburner engaged. An engine with supersonic cruise capability allows a fighter to perform in the manner a fighter without this capability would, were it using its afterburner all the time. At this time the F-22 is the only production fighter which has been designed from the outset for supersonic cruise.

Supersonic cruise capability of this kind also has to be designed into an aircraft from the outset and cannot be added by upgrades. While Russia has started producing a supersonic cruise engine for the Sukhoi fighters, these fighters were not designed for sustained supersonic flight and will not be competitive against the F-22.

The F-22 is a genuine multirole fighter, in that it is designed to defeat opposing fighters, and to attack the most heavily defended surface targets with smart bombs.

When used as an air superiority fighter, the F-22 has no peer in Beyond Visual Range combat, as its combination of stealth and supersonic cruise provides it with the ability to engage and disengage at will, in a fashion no other fighter can. In mock engagements flown in the US, the F-22 has repeatedly won engagements in which a single F-22 was pitted against multiple F-15 fighters.

In close combat the F-22 has greater agility than any fighter other than the most advanced Russian Sukhois.

The F-22 carries the most powerful and longest ranging radar ever fitted to an air combat fighter. This allows it to detect and engage targets from greater ranges than opposing and competing fighter types. The radar is so powerful, that the US Air Force envisage using it as a microwave Directed Energy Weapon to disrupt the electronics in opposing aircraft and cruise missiles, at close ranges. The F-22 is designated as the primary fighter to be employed by the US Air Force in the planned cruise missile defence architecture, by virtue of its ability to better detect small low flying cruise missiles, compared to all other aircraft.

When used as a bomber, the F-22 has unchallenged survivability in the face of the most capable air defence missile systems known and envisaged. The combination of supersonic cruise at high altitude and high performance stealth puts the F-22 out of the reach of most Surface to Air Missile types, and makes it effectively invisible to those Surface to Air Missile types with the performance to reach it.

Supersonic cruise capability contributes to the F-22's productivity, as it can transit distances at twice the speed of any competing alternatives, even allowing for aerial refuelling, and thus it can produce more sorties per day than any other fighter.

The F-22 can carry two internal 450 kg smart bombs or up to eight internal 175 kg Small Diameter Bombs, and has the inherent capability to carry up to four 1,000 kg external smart bombs or cruise missiles on wing pylons[19].

The radar in the F-22 has been enhanced to provide high resolution ground attack capabilities comparable to other state of the art strike fighters, providing it with the same autonomy as specialised bomber aircraft[20].

The US Air Force also intend to use the F-22 as an intelligence, surveillance and reconnaissance asset, exploiting its superlative sensors and exceptional survivability. In this role the F-22's supersonic cruise capability allows it to gather intelligence twice as fast as a conventional fighter.

Used either as an air combat fighter, a bomber, or an intelligence, surveillance and reconnaissance asset, the F-22 is more productive by virtue of its supersonic cruise capability, thus allowing a single

F-22 to do the work of two or more less capable conventional fighters[21].

Why is the F-22 the best strategic choice for Australia to replace its F/A-18A Hornets?

1. **Capability:** The F-22A is over twice as capable as alternatives, including the Joint Strike Fighters, in most roles.
2. **Strategic Position:** The F-22A is the only aircraft which has the capability to decisively defeat superior numbers of advanced Russian fighters in the region.
3. **Regional Independence and Credibility:** The F-22A confers exceptional capability and thus credibility to the ADF in the region, reducing Australia's dependency on US forces.
4. **Value for Money:** The F-22A has so much more capability than any other alternative, that it is the best value for money buy in the market.
5. **Better Life Cycle Growth Capability:** The F-22A is a large aircraft with greater system growth potential than any alternative.
6. **Longevity and Return on Investment:** The F-22A will remain effective and thus strategically credible much longer than any alternative.
7. **Low Technical and Financial Risk:** The F-22A is a known commodity that is is in production and operational today, unlike the Joint Strike Fighter.
8. **Clearly Defined Schedule:** Acquiring the F-22A in the 2010-2012 time window allows the replacement of the F/A-18A earlier with no capability gap.

2 Regional Capability Growth and Strategic Risk

This section explores the evolving region in terms of capability growth, and the strategic risks which arise as a result.

The ability to achieve and maintain air superiority in any escalated regional conflict is vital to Australia's future. Any regional crisis of substance, whether involving Australia alone or the US, would occur in a strategic environment which has seen the greatest geographically localised sustained long term investment in combat aircraft, guided weapons and supporting capabilities, since the last decade of the Cold War in Europe[22].

To put this in context, the aggregate number of new high capability category combat aircraft acquired or ordered across the Asia-Pacific-Indian region since the end of the Cold War numerically rivals the Warsaw Pact during its final decade. Importantly, many of these aircraft are evolved and improved derivatives of the last generation of combat aircraft deployed by the Soviets, and are technologically equivalent and often more advanced than the RAAF's current fleet, and US Navy and Air Force assets in this region[23].

As a result, three considerations become of critical importance to Australia.

The first of these considerations is that the absence of a decisive advantage in Australia's capability over regional nations provides opportunities for Australia to be coerced in any regional dispute. What would the outcome of the East Timor crisis have been if Indonesia had at that time parity or superiority in air power over Australia? In this context China's growth in long range air power is of particular concern.

The second consideration is that any regional dispute which devolves to a shooting conflict leaves Australia in the position where a limited capacity to defend high value economic assets and Navy and Army assets denies options. If the RAAF is unable to extend a protective umbrella over amphibious forces, as it is committed to defending the North West Shelf and Timor Sea energy industry, then amphibious operations are not an option. Air Warfare Destroyers cannot credibly provide such protection in a hostile environment. A future government is placed in the position where it may have to concede a regional dispute.

The third consideration is that Australia's standing and influence across the region will decline, as its capability declines relative to the region. Asia has been historically very competitive, and players who fall behind the majority in the region lose capacity to influence events. This behaviour is a byproduct of the regional cultural environment and cannot be avoided. Australia has for five decades relied upon its superior air power in this region to 'punch above its weight', a capability advantage now being abandoned.

Until recently, Australia has enjoyed an undisputed advantage in modern air power, numerically, technologically and in operational skills, over most nations in the region. This historical advantage is now disappearing as Asian nations buy some of the best products in the market.

Figure 11: *Advanced Flanker variants such as the Su-27SMK Flanker B, Su-33 Flanker D, Su-30MKI/MKK/MKM Flanker G/H and Su-35 Flanker E have key capabilities in common with modern US and EU fighters. These include aerial refuelling probes, buddy refuelling pods, advanced multi-mode radar strike modes, electro-optical targeting systems, digital network modems, glass cockpits and the capability to carry a wide range of smart munitions (Sukhoi, US Air Force).*

Figure 12: *Navalised Su-27 Flanker D variants, the Su-27K/Su-33 and Su-27KUB/Su-33UB, are being actively marketed to the PLA-Navy, which last year started to refurbish the former Soviet aircraft carrier Varyag in the Dalian shipyard. The single seat Su-27K/Su-33 and dual seat Su-27KUB/Su-33UB are full capability multirole fighters, which were the first to introduce many of the advanced design features now used on export Flanker variants (Sukhoi).*

Figure 13: *A key development over the last decade has been the emulation of US force structure models by major Asian air forces. Aerial refuelling is now a priority, with the Russian Ilyushin Il-78MK Midas adopted by India (upper) and China. Airborne Early Warning and Control Systems have been adopted even more widely than aerial refuelling in Asia. China is now testing an indigenous system, using the Russian Beriev A-50 Mainstay airframe and based on phased array radar technology of the same generation as Australia's Wedgetail system (lower). India has ordered the very similar Israeli A-50I, using a variant of the Elta Phalcon radar bid for Australia's AIR 5077 requirement, previously also bid to China (IAF, via Internet).*

2.1 Increasing Wealth in Asia and its Impact

The root cause of the changes in military capability we have been observing across the region is the industrialisation and thus increasing wealth of Asian nations.

What we observe is a pattern not unlike that seen in Europe over one hundred years ago, when rapid industrial growth resulted in an unprecedented concentration of wealth and power in Europe. This wealth fuelled the Great War, and the Second World War. During this period, Japan was the sole power in Asia to industrialise and this provided it with the capability to execute the military campaigns in China, South East Asia and the Pacific, all driven by a need for resources and markets.

Since 1950 we have seen Japan reconstitute its shattered economy, and subsequently climb to the position of Number 2 economic power after the US. More recently, South Korea has followed Japan and is now a significant manufacturing economy on the global scale. Both Taiwan and Singapore, despite their lesser size, have robust modern economies with significant high technology sectors.

The most important development over the last decade has been the rise of China as a major industrialised economy on the global scale. China will surpass Japan and become the world's Number 2 economic power after the US. With an enormous labour force by global standards, and the ability to control labour force costs, China has an unbeatable - and unfair - advantage in the globalised manufacturing economy.

China's rise has had numerous important consequences. The first of these is that the Chinese leadership is becoming increasingly preoccupied with access to materiel and energy resources, and markets for its manufactured products[24].

The second important consequence is that China has much more wealth available for military spending. This is reflected in unprecedented qualitative and quantitative changes in China's military capabilities, and an active shift away from the historical doctrines of continental defence, to a doctrine of regional dominance.

This capability growth is arising while China's relationships with other major regional players become increasingly competitive. The ongoing series of disputes between China and Japan is a good example.

With China acquiring a long range strike capability, there is potential longer term for conflicts with China to develop over regional energy resources, over access to distant resources or markets, over sea lanes and regional basing, and over Taiwan.

India is following a similar path of industrialisation to China, albeit more slowly, but with notable successes in areas such as information technology. Not unlike China, it is growing its military capabilities and thus its ability to project its influence and power across the region.

While India enjoys good relations with Western nations at this time, it has a well established history of pursuing its own interests with little regard for global, and especially Western, opinion. India's close relationship with the Soviet Union during the Cold War, and more recent disagreements with the United States over nuclear weapons policy, should be accepted as good indicators of India's independent pursuit of national goals.

For much of the last decade India and China pursued a 'tit-for-tat' strategy in the acquisition of advanced Russian military hardware, with India often acquiring the most sophisticated products Russia could supply. That relationship now includes Indian co-development and co-production of advanced Russian missile technology. It is likely the established competitive dynamic between China and India will continue through this century.

> The growth in wealth across Asia has also been reflected in the increasing quality of education and training across the region. The assumption that regional nations will continue to be weak in training capabilities and acquisition / support capabilities is no longer supportable. In the longer term we must assume that most regional nations will train their militaries to standards similar to the ADF.

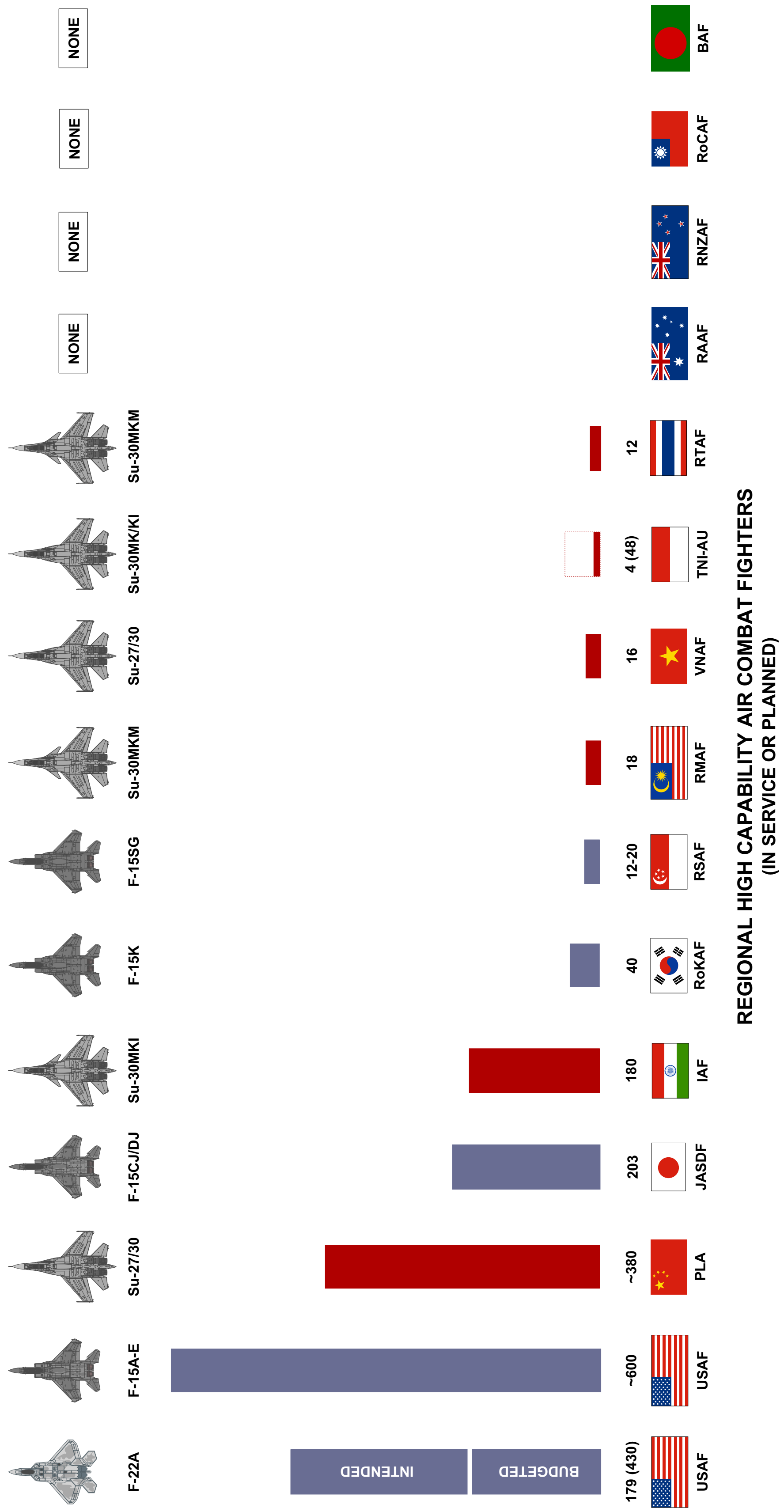

Figure 14: *This chart displays currently planned numbers of high capability category air combat fighters to be deployed by regional operators. Final numbers of the Su-27SK, Su-27SMK, Su-30MKK, Su-30MK2 Flanker B/G and derivatives remain to be determined, and Russian sources claim that in excess of 500 aircraft could be acquired by China alone. Taiwan has actively sought mothballed US F-15 fighters, but the US has not agreed as yet to provide the type. Australia, New Zealand and Bangladesh, uniquely, have no intent to deploy high capability category air combat fighters (C. Kopp).*

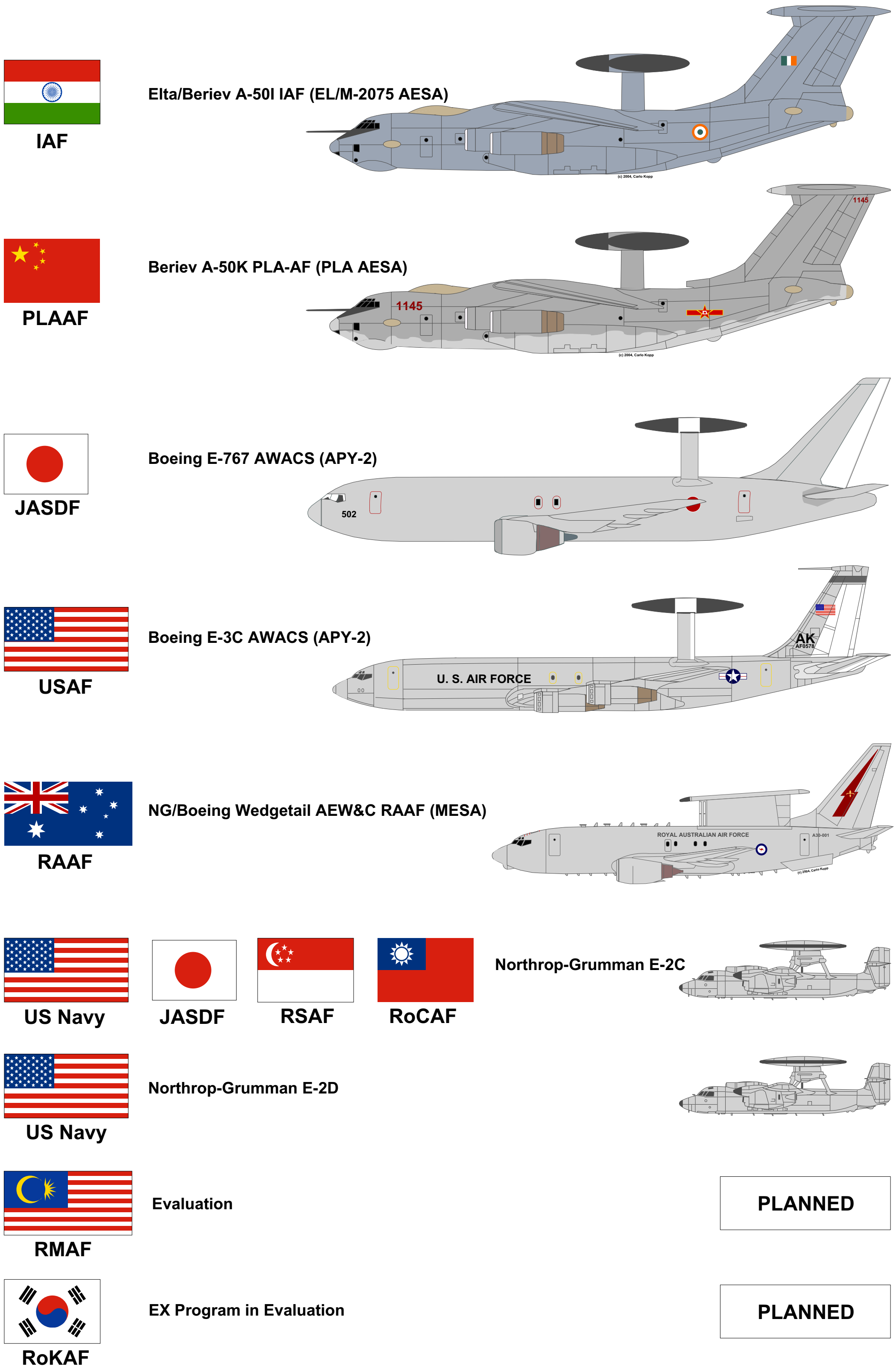

Figure 15: *Developing and deployed regional Airborne Early Warning and Control capabilities. Of specific interest is that the systems being acquired by India and China both employ state of the art phased array antenna technology. Final numbers of A-50 Mainstay aircraft to be deployed in the region remain unknown (C. Kopp).*

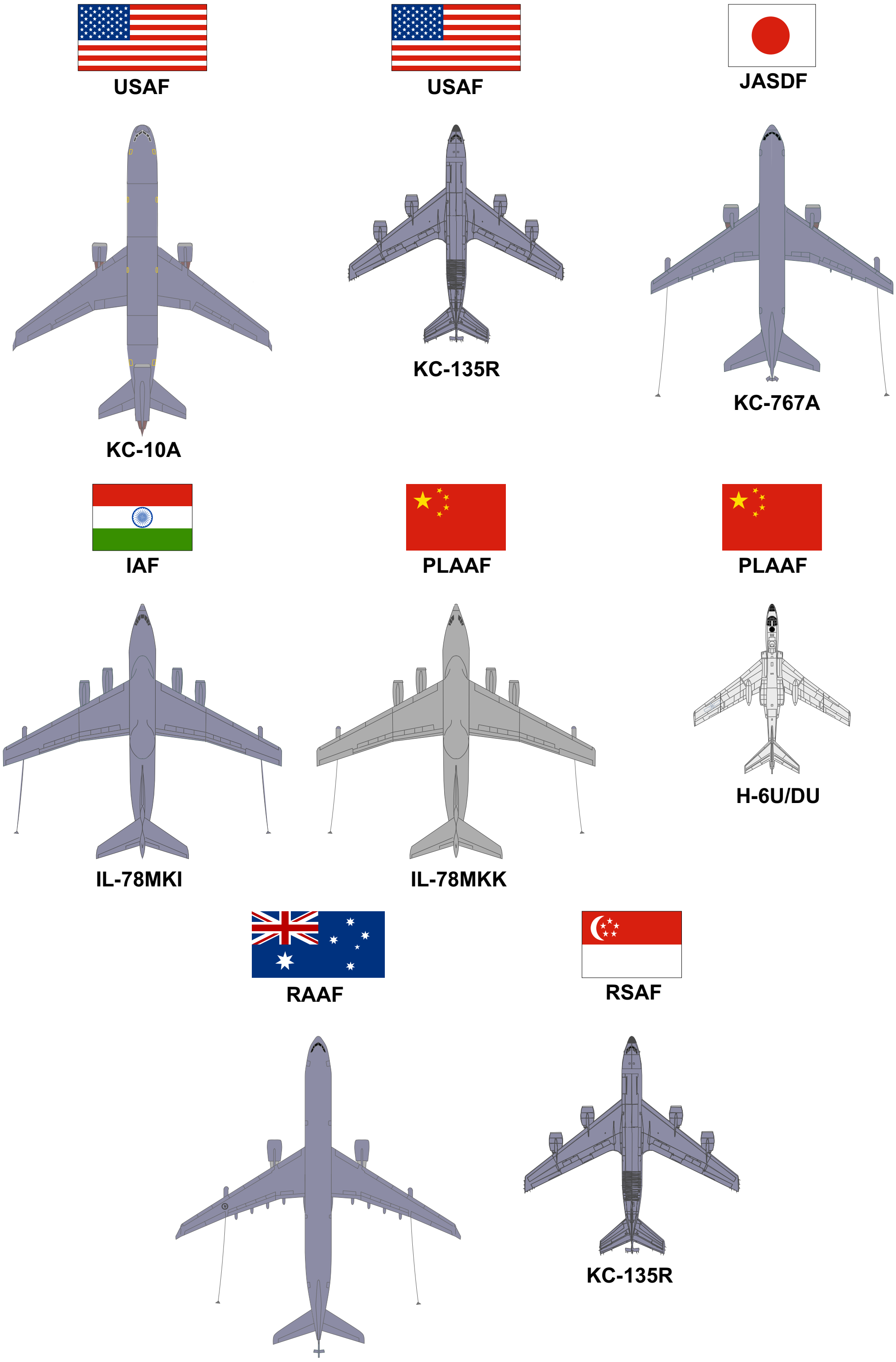

Figure 16: *Developing and deployed regional aerial refuelling capabilities. Of interest is that the Il-78MK systems being acquired by India and China both match the offload performance of US KC-135R. Final numbers of Il-78MK tankers deployed in region the remain unknown (C. Kopp).*

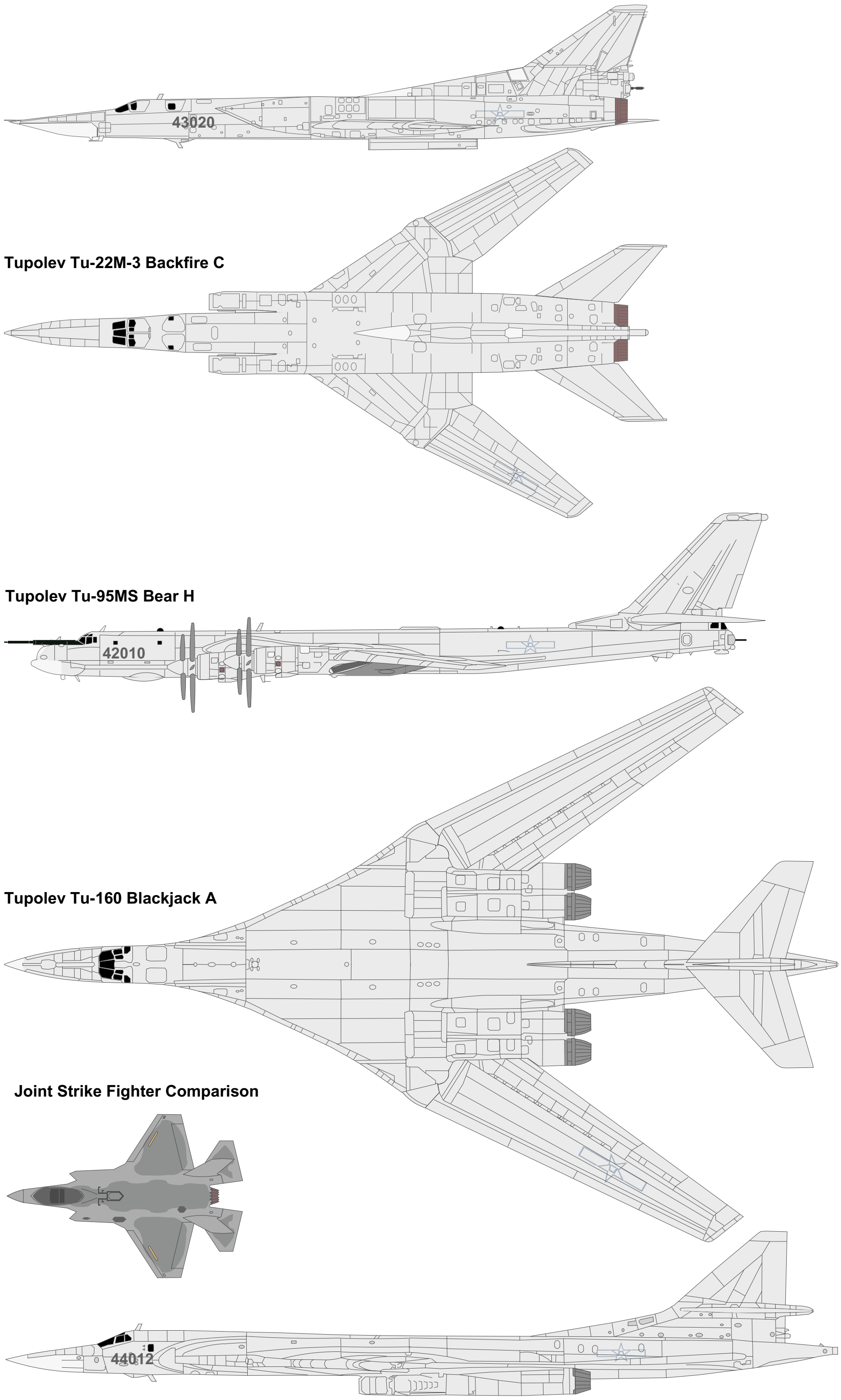

Figure 17: *Relative size comparison of the Tu-160 Blackjack A, Tu-95MS Bear H and Tu-22M-3 Backfire C strategic bombers against the Joint Strike Fighter. The Tu-160 carries up to twelve long range cruise missiles, the Tu-95MS up to sixteen, and the Tu-22M3 has the capacity to carry eight such weapons. The F-111 could carry four, the Joint Strike Fighter only two (C. Kopp).*

2.2 Increasing Capability in Asia and its Impact

The rapid growth in regional investment into modern air power, including key supporting capabilities historically used only by the US and NATO, indicates that Asian nations are doing their best to emulate established US doctrine on air power, and related force structure planning ideas.

US air power was for four decades unique in that it combined the use of combat aircraft with aerial refuelling tanker aircraft, large airborne surveillance systems such as AWACS/AEW&C for tracking hostile air activity, RC-135 Rivet Joint for surveilling hostile radar activity and communications, and airborne radar jammers such as the EF-111A and EA-6B Prowler. This force structure model was designed to support combat aircraft with additional fuel, with information on hostile movements, and to deny an opponent information by jamming.

> The pattern of purchases across Asia observed since the end of the Cold War closely emulates the US model. We have seen not only large high performance fighter aircraft acquired, but also aerial refuelling tankers and AWACS/AEW&C platforms. These choices by Asian buyers are clearly not arbitrary and reflect careful observation of US military doctrine and force structure.

Key air and missile capability acquisitions over the last 15 years, or currently in progress, include:

1. China acquiring up to 380 or more Sukhoi Su-27SK/SMK/J-11 Flanker B and Su-30MK Flanker G high capability category long range fighters;
2. China acquiring up to 1,000 indigenously developed Chengdu J-10 lightweight air combat fighters.
3. China acquiring Russian Ilyushin Il-78MKK Midas aerial refuelling tankers, similar in capability to the US Boeing KC-135R;
4. China developing an indigenous derivative Beriev A-50 Mainstay AWACS using similar radar technology to Australia's Wedgetail;
5. China manufacturing a range of indigenous cruise missiles, and illegally acquiring samples of the Russian Kh-55SM/AS-15B Kent strategic cruise missile;
6. China negotiating to buy surplus Russian strategic bombers, specifically the Tupolev Tu-22M3 Backfire, Tu-95MS Bear, and possibly new build Tu-160 Blackjack, similar to the US B-1B Lancer;
7. China restarting production of a sub-strategic cruise missile carrier variant of the Soviet era H-6 Badger bomber;
8. China acquiring a significant fleet of 3M-54 cruise missile armed Kilo class diesel-electric submarines;

9. China refurbishing the former Soviet aircraft carrier Varyag for sea trials; requests for flight demonstrations of navalised Su-27K/Su-33 and Su-27KUB/Su-33UB Flanker D carrier capable long range fighters.

10. China acquiring Russian smart bombs including the KAB-500 and KAB-1500 weapons, developing indigenous laser guided bombs, and acquiring the Russian Kh-59MK standoff weapon, similar to the AGM-142 weapon now carried by the ADF's F-111;

11. China acquiring the advanced Russian R-77 Adder Beyond Visual Range air to air missile, and developing an indigenous equivalent to the AMRAAM missile used by the US and the ADF;

12. China acquiring the Russian Kh-31P Krypton anti-radar missile;

13. China acquiring twelve or more batteries of the Russian S-300PMU Grumble long range mobile Surface to Air Missile system, equivalent to the US Patriot.

14. China funding development of the Russian S-400 Gargoyle long range mobile Surface to Air Missile system, which outperforms the US Patriot.

15. India acquiring 180 Sukhoi Su-30MKI Flanker H high capability category long range fighters;

16. India initiating a program to replace up to 400 or more legacy Soviet era fighters with new aircraft;

17. India acquiring A-50I Mainstay AWACS surveillance aircraft, using a derivative of the Israeli radar bid for the ADF's Wedgetail program;

18. India acquiring Russian Ilyushin Il-78MKI Midas aerial refuelling tankers, similar in capability to the US Boeing KC-135R;

19. India licensing the Russian Yakhont supersonic cruise missile as the indigenous Brahmos;

20. India buying into the development of the Russian R-172 'anti-AWACS' long range air to air missile;

21. India acquiring the Russian Admiral Gorshkov aircraft carrier and an air wing including MiG-29K Fulcrum air combat fighters and Russian Kamov AEW&C helicopters;

22. India tendering to upgrade and arm with cruise missiles its fleet of Tupolev Tu-142 Bear F maritime patrol aircraft;

23. India acquiring a significant fleet of 3M-54 Sizzler cruise missile armed Kilo class diesel-electric submarines;

24. South Korea acquiring 40 Boeing F-15K Strike Eagle high capability category long range fighters;

25. South Korea tendering to acquire AEW&C aircraft;

26. Japan acquiring Boeing E-767 AEW&C aircraft;

27. Japan acquiring Boeing KC-767 aerial refuelling tanker aircraft;

28. Singapore acquiring Boeing KC-135R aerial refuelling tanker aircraft;
29. Singapore acquiring Northrop Grumman E-2C AEW&C aircraft;
30. Singapore acquiring 20 or more Boeing F-15SG Strike Eagle high capability category long range fighters;
31. Vietnam acquiring a mix of Russian Su-27/30MKV Flanker B/G high capability category long range fighters;
32. Malaysia ordering Russian Su-30MKM Flanker H high capability category long range fighters;
33. Malaysia tendering to acquire AEW&C aircraft;
34. Indonesia acquiring an initial batch of Russian Su-27/30MK Flanker B/G high capability category long range fighters, publicly stating that up to 48 are being sought;
35. Russia actively marketing L175V / KS418 high power standoff jamming pod equipment in Asia;
36. Russia actively marketing airborne networking equipment in Asia;

While the growth in capabilities observed spans the whole region, China is by far the most prominent in the scale and scope of its military growth.

This reflects a deep shift in China's strategic doctrine. Historically China oriented its military aviation force structure around direct defence of the mainland, and to a lesser extent toward striking at targets in the 'first island chain' encompassing the Aleutians, Kuriles, Japan, Okinawa, the Ryukyu island chain, Taiwan, the Philippines and South East Asia.

China's recently adopted 'second island chain' strategy extends the footprint of China's offensive air capabilities to cover a geographical area across an arc between the Bonins, Guam, Marianas, Palau and northern coastline of Australia, all identified as 'US basing sites'. Specific capabilities being acquired to support the new 'second island chain' strategy include aerial refuelling for the Sukhoi Su-27SMK/30MK long range fighters, strategic bombers, air launched cruise missiles and additional cruise missile armed submarines.

As these capabilities mature over the coming decade, there will be a fourfold strategic impact upon all smaller nations in the region.

Impact 1 - The PLA acquires the capability to coerce regional nations including Australia using strategic bombers and/or submarines armed with cruise missiles;

Impact 2 - The PLA acquires the capability to threaten shipping lanes in/out of the Far East including the northern approaches to Australia, using strategic bombers and/or submarines armed with cruise missiles;

Impact 3 - The alignment of some smaller regional nations will shift away from US to China, ie the effect known as 'Finlandisation' after Finland's submission to the Soviets during the Cold War era;

Impact 4 - The PRC will continue its current program aimed at isolating the US from its regional allies long term.

It is clear at this time that China will have a capability, by the end of this decade, to project air power using aerial refuelling and most likely strategic bombers, to the full footprint envisaged by the 'second island chain' strategy.

Importantly, this capability will be bounded by two key force structure constraints. The first is the number of strategic bombers acquired and supporting warstocks of cruise missiles. The second is the number of aerial refuelling aircraft, which limits how many Sukhoi fighters can be used as long range escorts or strike platforms. Unless China can acquire secure basing in South East Asian nations for its Sukhoi fighters, it will be numerically limited in what firepower it can project into Australia's sea-air gap and northern geography.

The broader and deeper strategic consideration arising from China's developing capabilities is that the region is now transitioning from capabilities which are limited in geographical reach, to capabilities with significant geographical reach. Therefore, placing arbitrary geographical constraints on what constitutes Australia's area of regional interest, or indeed what constitutes the 'region' is now irrelevant. *For all intents and purposes the definition of the 'region', in defence strategic planning, must encompass all nations in the Asia-Pacific-Indian region which have or will have the capability to project military power, especially air and missile power, into Australia's immediate geographical vicinity.* ADF force structure planning should henceforth be predicated on this definition of the 'region', not the now historical definition which encompasses only South East Asia.

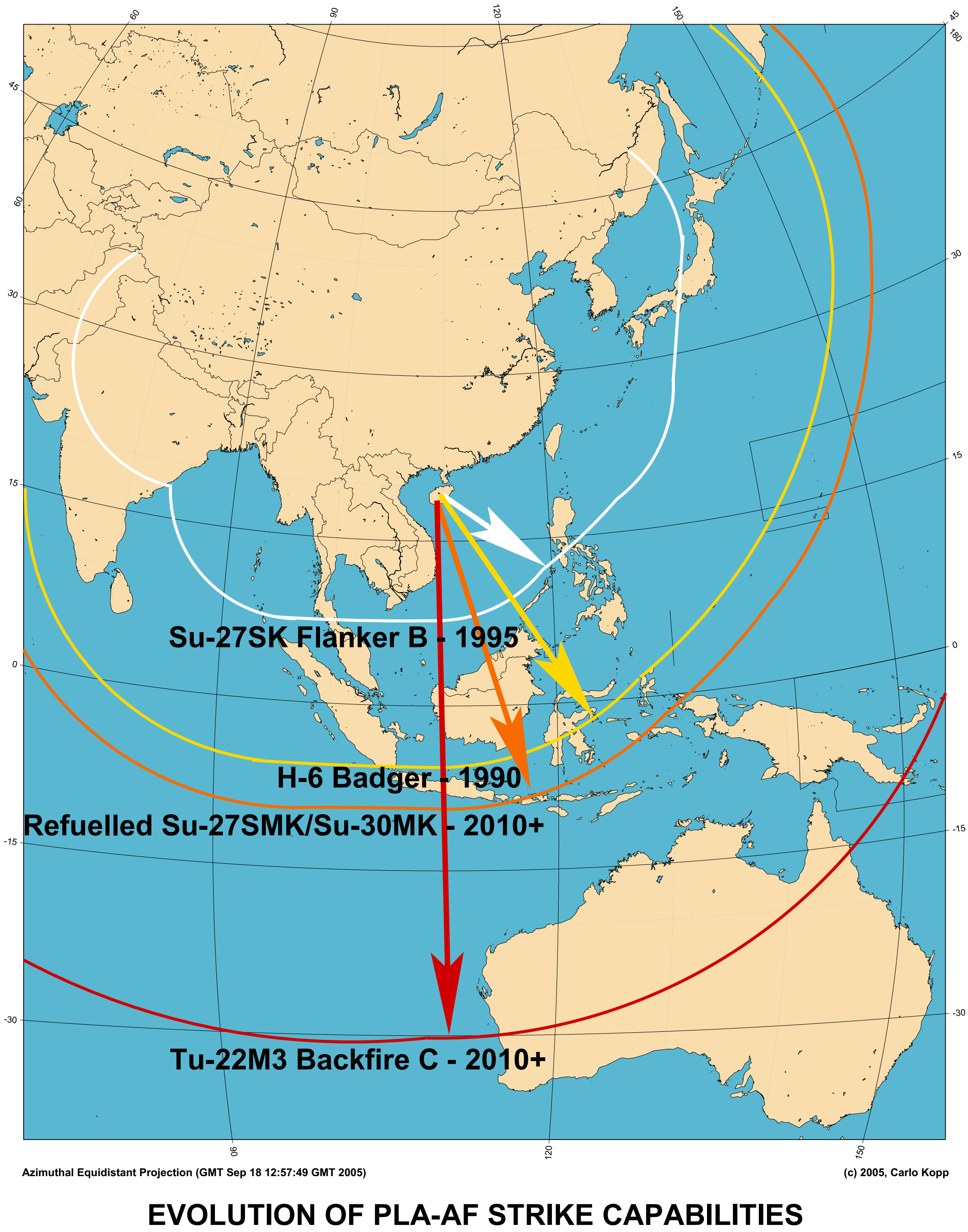

Figure 18: *China has made significant investments in strike capability over the last 15 years. In 1990 China was limited to the H-6 Badger (yellow), by 1995 China had acquired long range Su-27SK fighters (white). In 2005 China has ordered Il-78MKK aerial refuelling tankers, to support Russian supplied Su-30MKK strike fighters and indigenously assembled Su-27SMK strike fighters (orange). At this time China is negotiating a buy of the Tu-22M3 Backfire strategic bomber (red) and possibly the Tu-95MS cruise missile carrier. This represents the fastest growth in strategic strike capability, globally, since the onset of the Cold War in Europe (C. Kopp).*

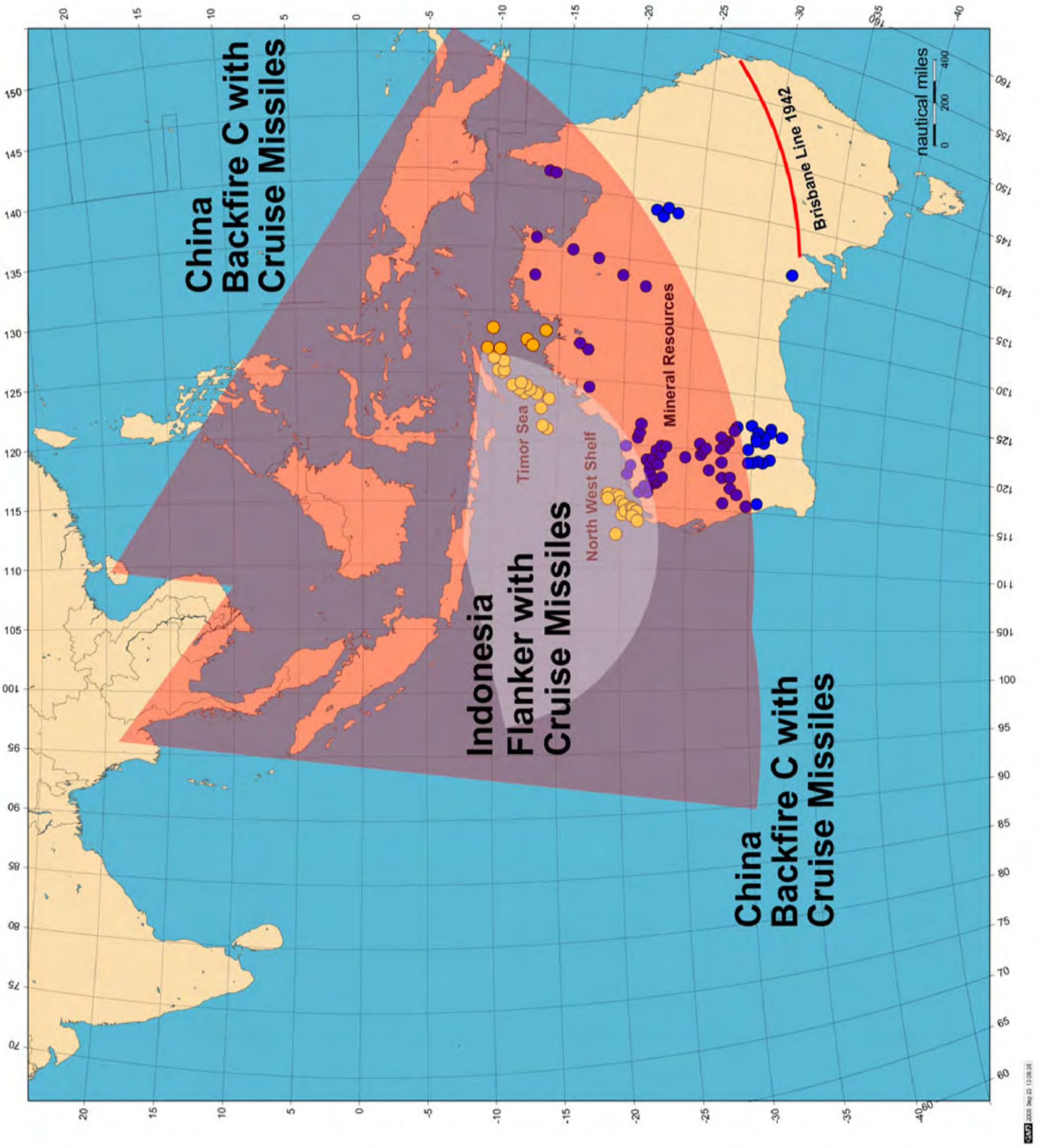

Figure 19: *This chart displays the coverage footprints of representative weapon systems being sought, acquired or operated across the region, against Australia's landmass. Resource sites are current as of early 2005 (C. Kopp).*

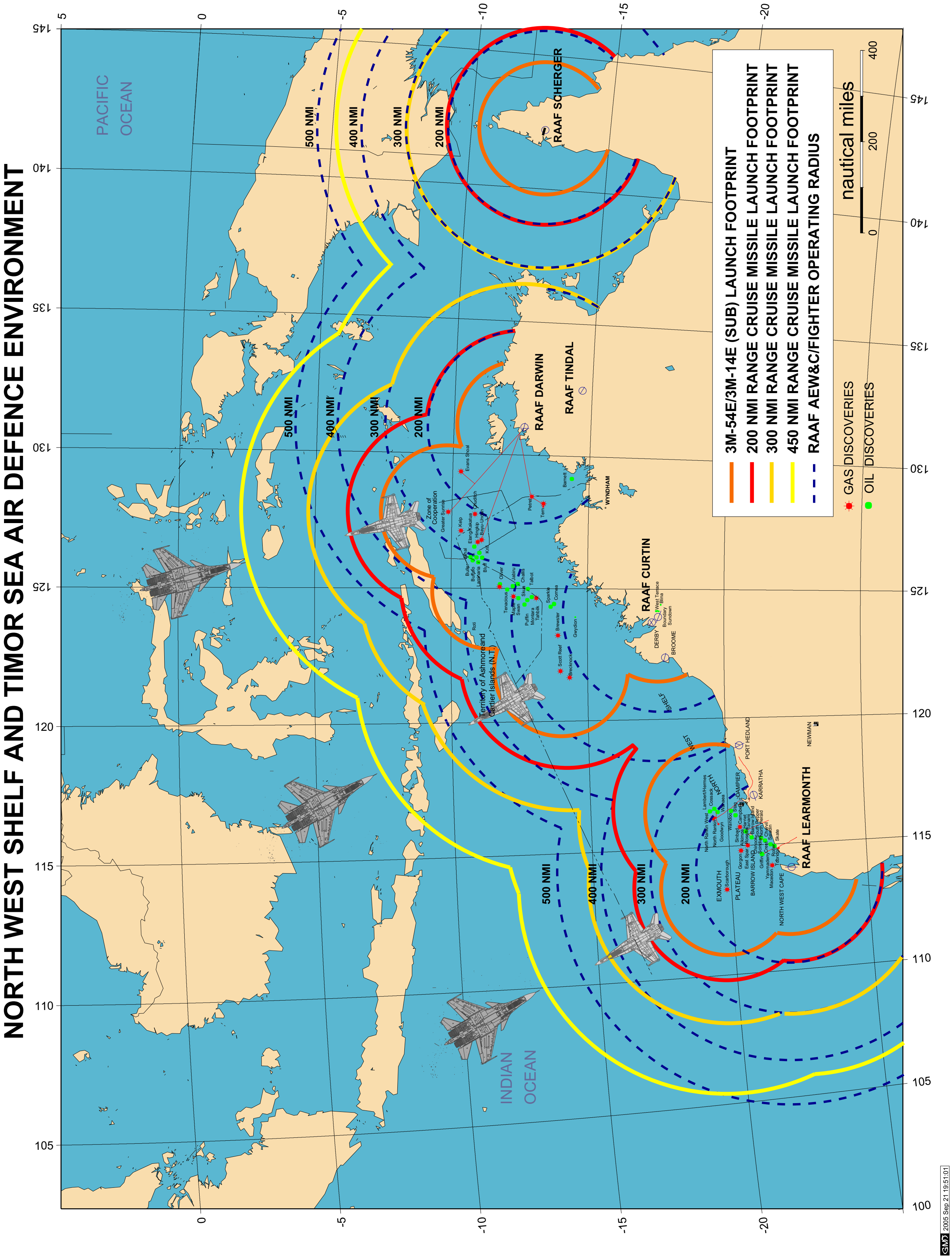

Figure 20: *This map depicts key features of the North West Shelf and Timor Sea air defence environment, comparing cruise missile launch footprints against Australian targets with operating radii from RAAF basing (C. Kopp).*

2.3 Dealing with Strategic Risks to Australia

We define a strategic risk as an event or situation which may arise in the future, which has some strategic impact or consequences, and some chance of occurring. An event of low strategic risk is such, that the chances of it occurring may be low, modest or high, but its strategic impact or consequences are not critically important. Conversely, an event of high strategic risk is such, that it has a large strategic impact or consequences, even if its chances of arising are low or modest. Finally an event of very high strategic risk is such an event, which has large strategic impact or consequences, and the chances it may arise are very strong.

> The unprecedented growth in regional military capabilities, especially air power and cruise missile capabilities, represent at this time a high long term strategic risk for Australia, as the consequences of any regional shooting war would be significant, especially in the potential for economic damage, civilian casualties, and loss of ADF assets and personnel. Should the currently difficult relationships between China and Taiwan, China and Japan, or China and the United States degrade further over time, then this would represent a very high strategic risk for Australia, given the gravity of the resulting consequences.

The ability to achieve and maintain air superiority within regional areas of strategic interest to Australia, such as the air-sea gap, is critical to containing or limiting the possible consequences of developing strategic risks in the region, or circumstance permitting, pre-empting such risks.

The ideal situation given the developing regional environment is that Australia can wholly deter the use of regional air power and missile capabilities against Australian interests or territories. Successful deterrence, however, is critically dependent upon potential opponents' perceptions of Australian capabilities, and Australia's willingness to use those capabilities. If a potential opponent sees the capability equation in a way in which Australia is unable to credibly achieve air superiority, then deterrence will fail and conflict becomes an option to be pursued.

Therefore a well planned force structure for the RAAF must not only be capable of dealing with the developing strategic risks, by defeating opponents in combat, but also be visibly seen across the region to be capable of inflicting unacceptable losses and defeating any operation conducted by a regional nation.

It is fashionable in some Australian circles to see the United States as the principal provider of capabilities required to deter or defeat any significant regional campaign against Australia. This line of reasoning provides a rationale for not equipping the ADF with critically important capabilities, especially those required for achieving air superiority, or performing counterforce strikes against regional air power and missile basing.

The ongoing debate in the United States over defence funding, which has unfolded over the last two years, reflects an inevitable reality. The United States is suffering 'strategic overstretch', with sustained military expenditures in Iraq, Afghanistan, Africa and other theatres in the Global War on Terror, draining resources. Funding these campaigns and attempting to avoid significant long term growth in deficits presents genuine issues. The Quadrennial Defense Review conducted in 2005 reflects this reality, with unprecedented short, medium and long term reductions in force structure investments. Paying for the present and near future is eroding long term United States capabilities, especially in air power. The United States Air Force currently faces the unpalatable realities of not having funds to fully 'recapitalise' key force structure components, built up during the decades of the Cold War era.

In strategic terms the US faces two challenges in the early 21st century. The first of these is the Global War on Terror, the second of these is balancing the growing strategic weight of China, and to a lesser extent, India in the Asia-Pacific-Indian Ocean regions. Maintaining the required qualitative advantage in force structure capabilities, while maintaining credible numbers, will be unusually difficult. Key systems under threat include replacements for the tanker fleet, large surveillance assets, and larger unmanned surveillance platforms.

If we are to assume that a future US administration is prepared to deploy significant air power to support Australia in a regional contingency involving the use of modern air power and cruise missiles on the part of the aggressor, the difficulty which arises is that of numbers of available assets the US can deploy, and how soon these can be deployed. The United States Air Force will have a shortage of aerial refuelling tankers, high capability category air superiority and strike fighters such as the F-22A, surveillance systems like the AWACS, Rivet Joint and JSTARS, standoff jamming aircraft and large surveillance systems like the Global Hawk. The United States will be much more easily able to deploy less capable lower tier assets, such as the Joint Strike Fighter and legacy fighter aircraft. However, the utility of such assets in the types of conflicts which might arise within Asia is questionable.

It will be strategically unsafe for Australia to rely upon the United States to provide key high capability category assets for the defence of Australian interests and territories. The United States may find itself in the position where it cannot meet such needs at short notice, simply due to shortages in available numbers of such assets, or it may be presented with a genuinely difficult conflict of interest. The consequence is that Australia must properly invest in key assets, these including high capability category fighters, aerial refuelling tankers, surveillance and jamming aircraft and other supporting capabilities.

It is in Australia's interests to maintain the capability to act unilaterally and independently within the region, a capability which will be lost if current Defence planning is pursued. This does not preclude maintaining a close relationship with the United States. Clearly it enhances the relationship with the United States as it reduces the number of assets the United States would otherwise have to budget for this region to cover Australia's currently developing strategic weakness, and provides Australia the option of offering high capability category assets for future coalition operations with the United States. There is considerably more political gain in providing a United States' led coalition force with the kinds of capabilities which the United States does not have in abundance.

The character of capabilities now being developed in Asia is of forces designed for coercion, rather than seizure of territory. This is a model which emulates the United States' use of air power as a coercive weapon, demonstrated in the air campaigns of the 1990s. By inflicting heavy damage on an opponent's military and civilian infrastructure, the opponent is forced to concede a dispute.

Australia's ability to generate economic wealth has evolved since the 1940s, when New South Wales and Victoria were the nucleus of the nation's wealth generating economy. Today and in the future increasingly so, Australia's wealth in mineral and especially energy resources will become central to national wealth. These resources are mostly concentrated in the northern and western parts of Australia's landmass, and its continental shelf.

This accident of geography leaves Australia highly exposed to the coercive use of air power and cruise missiles against key economic targets.

In a future dispute with a regional nation, much of Australia's wealth generating resource industry could be shut down, crippled, or even destroyed, for a modest expenditure in smart bombs or cruise missiles. The oil and gas industries are especially vulnerable, due to their highly combustible product. It is worth observing that the Burrup Peninsula and planned Gorgon Liquefied Natural Gas storage facilities each, when full, store energy equivalent to a Megatonne class nuclear warhead.

Given the enormous economic cost, and likely significant collateral environmental damage, arising from a smart bomb or cruise missile attack on an energy industry target, a future government may be faced with very difficult choices if a dispute arises with a regional nation, in possession of smart bomb or cruise missile equipped combat aircraft. Unless the RAAF can credibly defeat such capabilities in combat, the government may well be compelled to capitulate on the day.

Defeating or deterring the use of cruise missile or smart bomb equipped combat aircraft, supported by aerial refuelling tankers, or submarine launched cruise missiles, is not an easy task.

Defeat of an attacker requires the aircraft carrying smart bombs or cruise missiles must be intercepted well before they reach the release point for the weapon, possibly hundreds of miles for a cruise missile, and destroyed. Moreover, any cruise missiles which have been launched must be intercepted and destroyed. If cruise missiles are launched by submarine, interception of the missiles is the only option.

Deterrence of an attacker requires that the attacker understand that most of their assets used in such an attack would not survive an encounter with ADF defensive assets, or offensive assets. If the ADF develops the capacity to project striking power to distances of thousands of nautical miles, then deterrence by the threat of a 'counter-force' strike becomes an attractive option. This is the model which served Australia well during the pre-Timor era, when F-111s were available to effect long range 'counter-force' strikes.

Given the geographical constraints Australia faces, and the growing importance of regional sea lanes to the many Asian economies, control of these sea lanes will become a major issue in the medium and long term. At this time only the United States Navy have the ability to robustly control these sea lanes, but China's developing naval capabilities and stated doctrine indicate that control of regional sea lanes is becoming a priority.

If Australia is to deny control of its northern sea lanes to another power, such as China, then Australia needs the capability to attack surface shipping across the nearer region. In practical terms this means combat aircraft and enough supporting aerial refuelling tankers to saturate an opposing surface fleet's defences with anti-shipping cruise missiles. Australia cannot play in the game of sea control since the nation's economy cannot support the size of naval surface fleet required.

Should Australia develop its future air power following a rational and well structured model, then its influence in the region will grow, as it will be robust ally who is not easily swayed in a dispute.

Other dividends accrue, as noted, as a reduced dependency on US assets takes a burden off the US taxpayer, otherwise placed in the position of having to hold assets in reserve to attempt to cover Australia's weakness, or decline assistance at short notice in a crisis situation.

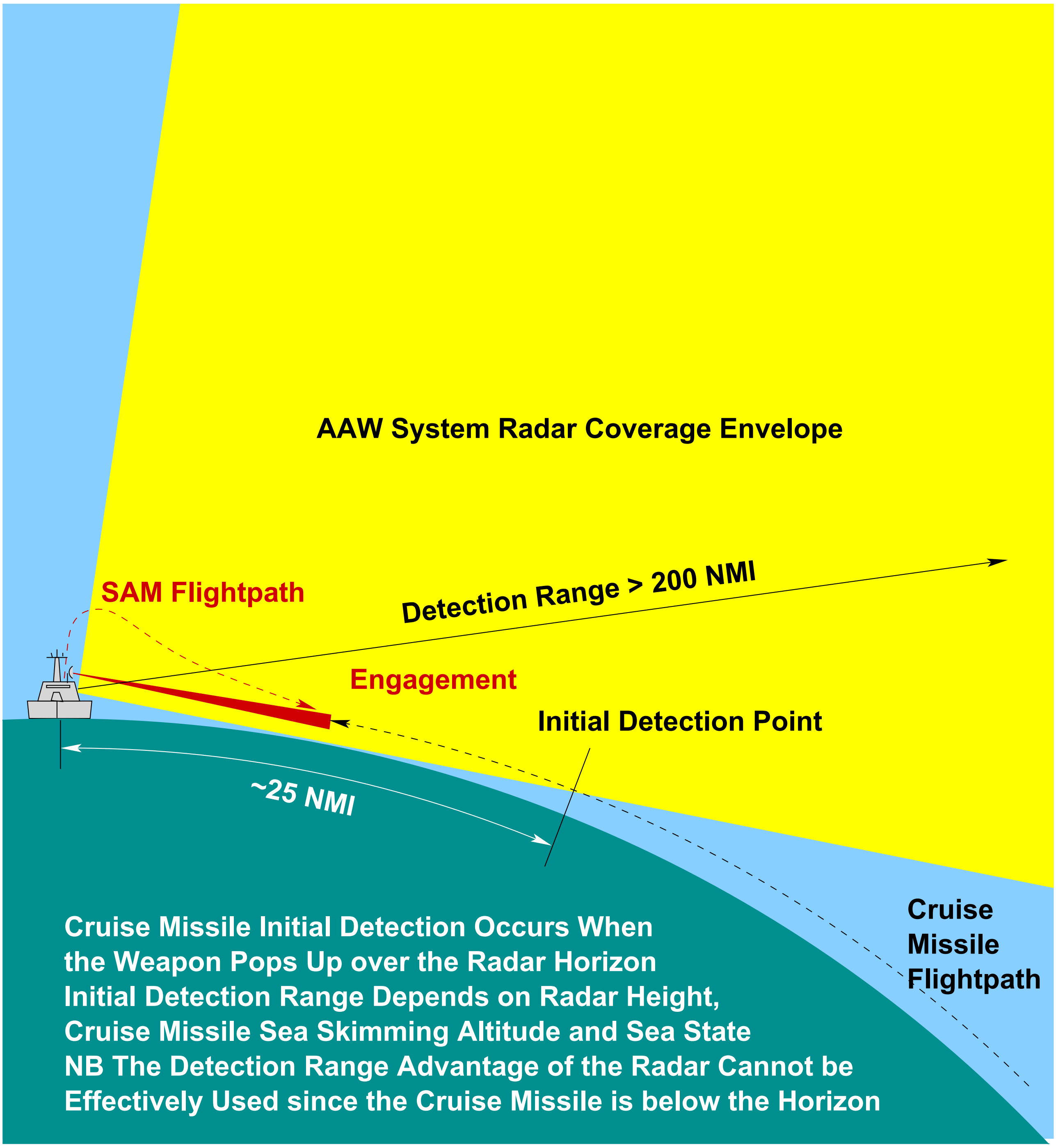

Figure 21: *The notion that the Air Warfare Destroyers can significantly contribute to Australia's capability to defend airspace is predicated on completely unrealistic assumptions about regional capabilities. The most likely weapons which will be used for maritime strikes and attacks on land targets will be low flying cruise missiles. While the long range radar system on a warship has the potential to detect high flying targets from 200 nautical miles distance, its capability to detect low flying cruise missiles is limited to the radar horizon of the warship, typically around 25 nautical miles or less distance away. In practical terms the Air Warfare Destroyer can cover a low altitude footprint with only 1/100th the area covered by a single Wedgetail Airborne Early Warning and Control system (C. Kopp).*

2.4 Achieving Credible Regional Air Superiority

Achieving air superiority in any strategic context requires that an air force have better capabilities than potential opponents, in credible numbers relative to opposing capabilities.

The developing regional environment presents Australia with many challenges which have not been seen since the period of the 1940s, when Japanese forces were able to strike at northern Australian targets. Until later in that conflict, Australia had a very limited capability to challenge or defeat Japanese bombers and their supporting escort fighters.

Unlike the period of the 1940s, Australia now derives significant national wealth from natural resources in the north. The North West Shelf and Timor Sea gas and oil industry plant, offshore and onshore, represents a lucrative target for air attack using smart bombs or cruise missiles, and thus is a key strategic vulnerability in a time of conflict.

Other key targets across Australia's north include the chain of RAAF airfields, specifically Learmonth, Curtin, Tindal, Darwin and Scherger. Relatively isolated, repair and reconstitution of most of these bases following attacks could present genuine difficulties.

In any serious conflict, initial attacks would be directed at RAAF bases and where opportunities arise, RAN surface warships in the area. The aim would be to at least cripple operations, and if possible render the basing unusable and inflict attrition on aircraft and other assets. The weapon of choice for such attacks would be the cruise missile, launched in large numbers. For instance, a Sukhoi Su-27/30 fighter supported by aerial refuelling has the capacity to carry up to four conventional cruise missiles, or a smaller number of supersonic cruise missiles. A strategic bomber would carry between four and sixteen cruise missiles, subject to bomber and missile types, and would not require aerial refuelling for such strikes.

The often cited argument that the Air Warfare Destroyers could play a major role in defending against such a strike is nonsense, as each of these vessels could at best defend a circle of about 30 nautical miles diameter against a low altitude cruise missile attack, assuming the warship itself does not become the focus of an attack. The operational and propaganda effect of sinking one or more of the Air Warfare Destroyers makes them an attractive target, one which is implicitly susceptible to a saturation attack with anti-ship cruise missiles[25].

Given these considerations, defining key capabilities to achieve and maintain air superiority within Australia's areas of interest is not unusually difficult. Developing regional capabilities provide a very clear and easily understood benchmark for future RAAF capabilities. NATO and United States experience during the Cold War era provides a wealth of applicable case studies.

Key capabilities which Australia must acquire can be summarised thus:

1. Capability to defeat Sukhoi Su-27SK, Su-27SMK, Su-30MK Flanker and future growth variant fighters, including models equipped with supersonic cruise engines. The Sukhoi must be defeated in both Beyond Visual Range and close combat, the latter to account for situations

where Beyond Visual Range combat is not feasible.

2. Capability to defeat strategic bombers such as the H-6 Badger, Tu-95MS Bear and Tu-22M3 Backfire. Fighter aircraft must have the supersonic performance to effect intercepts against supersonic bombers, and be supported with sufficient refuelling capability to engage the bomber before it can launch cruise missiles.

3. Capability to defeat cruise missiles, including the Tomahawk-like Kh-55SM, and supersonic weapons like the Yakhont. Fighters must have the aerodynamic performance, radar performance and weapon payload to credibly intercept low flying cruise missiles in flight. Sufficient aerial refuelling must be available to provide the necessary persistence in an area of operations.

4. Capability to perform long range 'counter-force' strikes to pre-emptively defeat regional offensive capabilities in a crisis. This capability can be implemented by delivering cruise missiles, or by employing a penetrating stealth aircraft. Sufficient aerial refuelling capability must be available to permit a significant number of aircraft to reach targets at distances of 2,500 nautical miles or greater.

These basic capabilities must exist, and sufficient numbers of aircraft be available for the capability to be credible. For instance, having the capability to strike to 2,500 nautical miles using only eight aircraft is not a credible capability.

Additional and important considerations also include:

1. Achieving sustainability in operations - the RAAF must be capable of sustaining these capabilities, at a credible rate of effort, for at least two months. This means not only having sufficient aircrew and ground personnel, but also having the airfield aviation fuel replenishment capability and critical munitions warstocks to sustain the effort.

2. Achieving persistence and reach - aerial refuelling aircraft of suitable size must be available in credible numbers to support persistent air combat and battlefield support tasks, but also to permit credible numbers of aircraft to strike at long range, or sustain Combat Air Patrols over the sea air gap.

3. Achieving situational awareness - sufficient numbers of intelligence, surveillance and reconnaissance systems must be available to provide persistent coverage of areas of operation. Having world class systems like the Wedgetail AEW&C is not adequate if the number of aircraft is not sufficient to cover all key Australian territorial targets.

4. Achieving network robustness - while networking capabilities are highly valuable in combat, they represent a single point of failure for the force if they are degraded or crippled by hostile jamming. Sufficient redundancy must exist within networks to provide high resilience to hostile jamming.

5. Jamming opposing networks and intelligence, surveillance and reconnaissance systems. All successful air campaigns executed over the last three decades have included intensive jamming of an opponent's radar and communications systems. This capability is essential given developing regional capabilities.

6. Coalition interoperability issues - communications, digital networks, radars and jamming equipment must be interoperable with United States forces.

Current planning for the RAAF, articulated in a range of public documents, is wholly unrealistic given the developing strategic environment, and regional capabilities.

If we test planned capabilities against the previously stated criteria, several key inadequacies become immediately apparent.

1. The F/A-18A HUG is outclassed by the Sukhoi fighters on a number of key criteria, including combat radius, aerodynamic performance, radar range and weapon carrying capabilities.
2. The Joint Strike Fighter is outclassed by the Sukhoi fighters on a number of key criteria, including combat radius, aerodynamic performance and weapon carrying capabilities. The United States intend to use the F-22A to defeat Sukhoi fighters in air combat.
3. The F/A-18A HUG lacks the supersonic performance to reliably effect intercepts against high performance strategic bombers like the Tu-22M3 Backfire.
4. The Joint Strike Fighter lacks the supersonic performance to reliably effect intercepts against high performance strategic bombers like the Tu-22M3 Backfire - the United States intend to use the F-22A for this role.
5. The F/A-18A HUG lacks the persistence and weapon carrying capability to be an effective cruise missile defence asset, and its radar lacks the range performance to perform this role effectively.
6. The Joint Strike Fighter lacks the persistence and weapon carrying capability to be an effective cruise missile defence asset - the United States intend to use the F-22A for this role.
7. Current planning to acquire five A330-200 aerial refuelling tankers addresses around 25% of the developing capability needs of the RAAF.
8. Current planning to acquire six Wedgetail AEW&C aircraft addresses around 66% to 75% of the developing capability needs of the RAAF.
9. There is no planning to acquire a long range ground surveillance platform with capabilities similar to the US E-8 JSTARS.
10. There is no planning to acquire a long range electronic and signals surveillance platform with capabilities similar to the US RC-135V/W Rivet Joint or EP-8A.
11. There is no planning to acquire support jamming aircraft to suppress opposing radar, network and communications systems.

It is abundantly clear that current planning for the future of the RAAF is predicated on unrealistic and obsolete assumptions about regional capabilities and their impact. As a result it should be wholly revised to account for the evolving region and developing strategic risks. To retain the existing plan for future air force capabilities is to invite significant problems for Australia over coming decades.

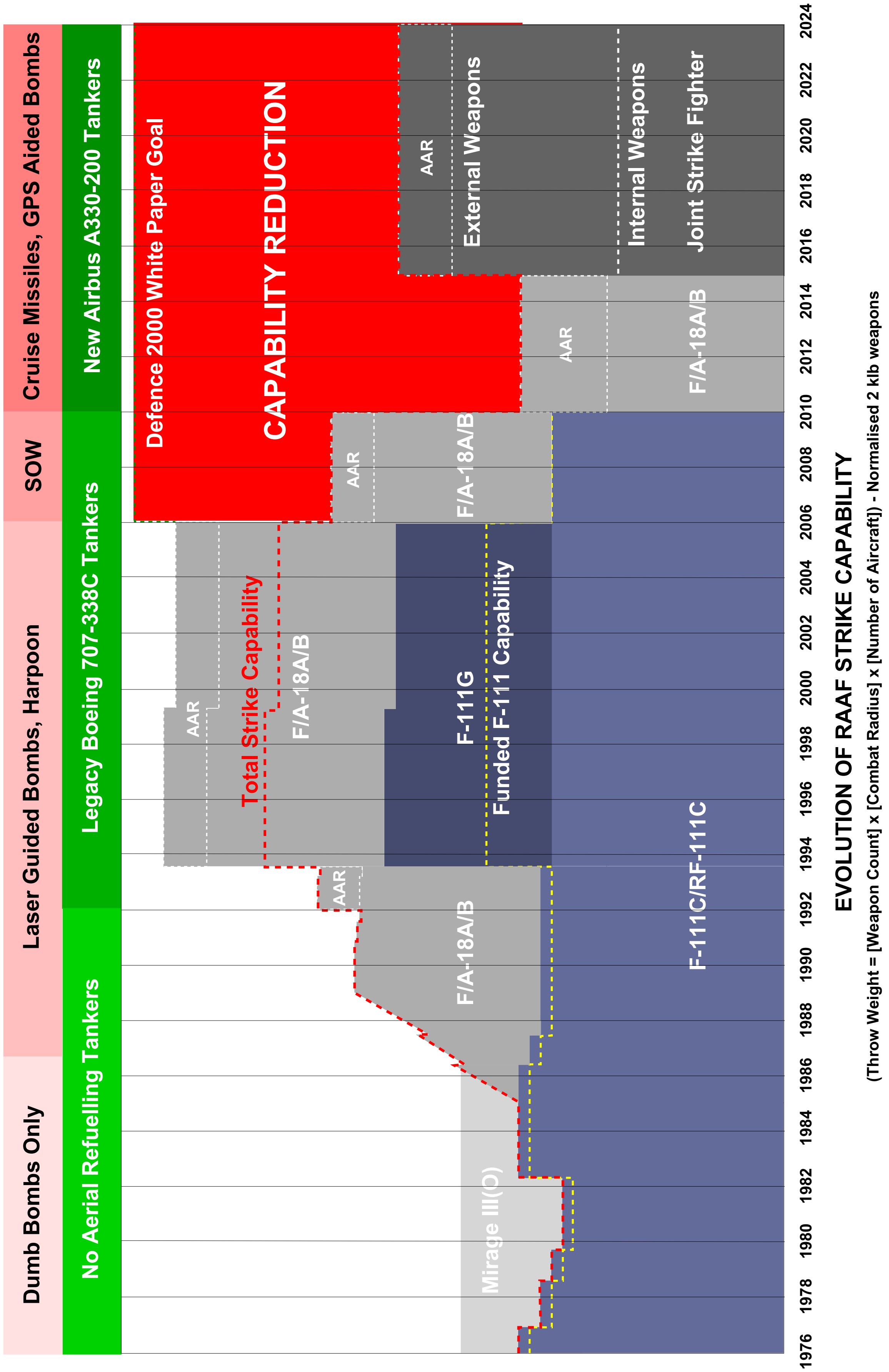

Figure 22: *This chart displays the evolution of RAAF strike capability and current planning for the period following 2005 (C. Kopp).*

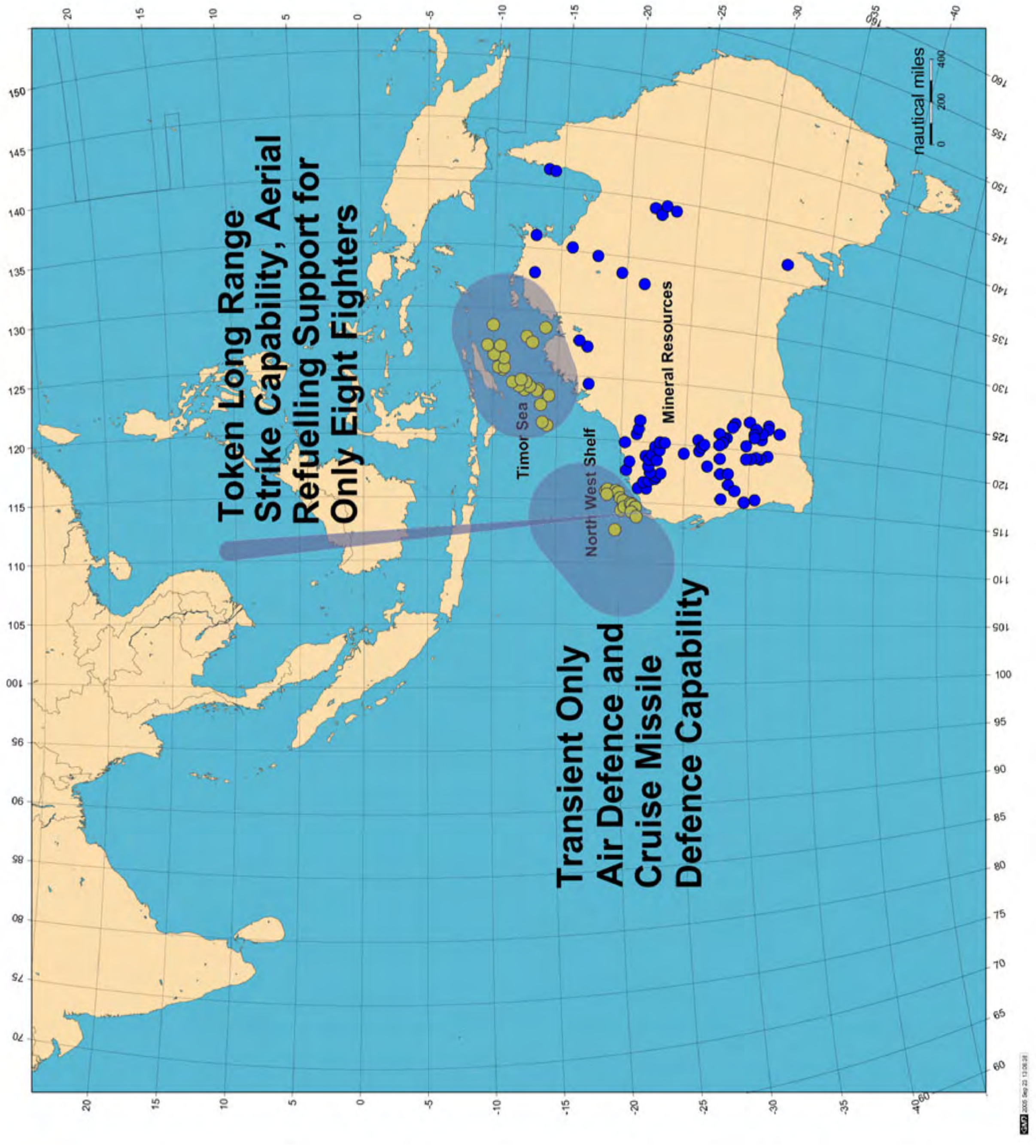

Figure 23: *This chart displays the air defence and long range strike capabilities as currently planned for in the interim and final RAAF capabilities. The notable limitations in long range capability arise from inadequate numbers of aerial refuelling aircraft, exacerbated further by a preference for small low capability category fighters such as the F/A-18A and Joint Strike Fighter (C. Kopp).*

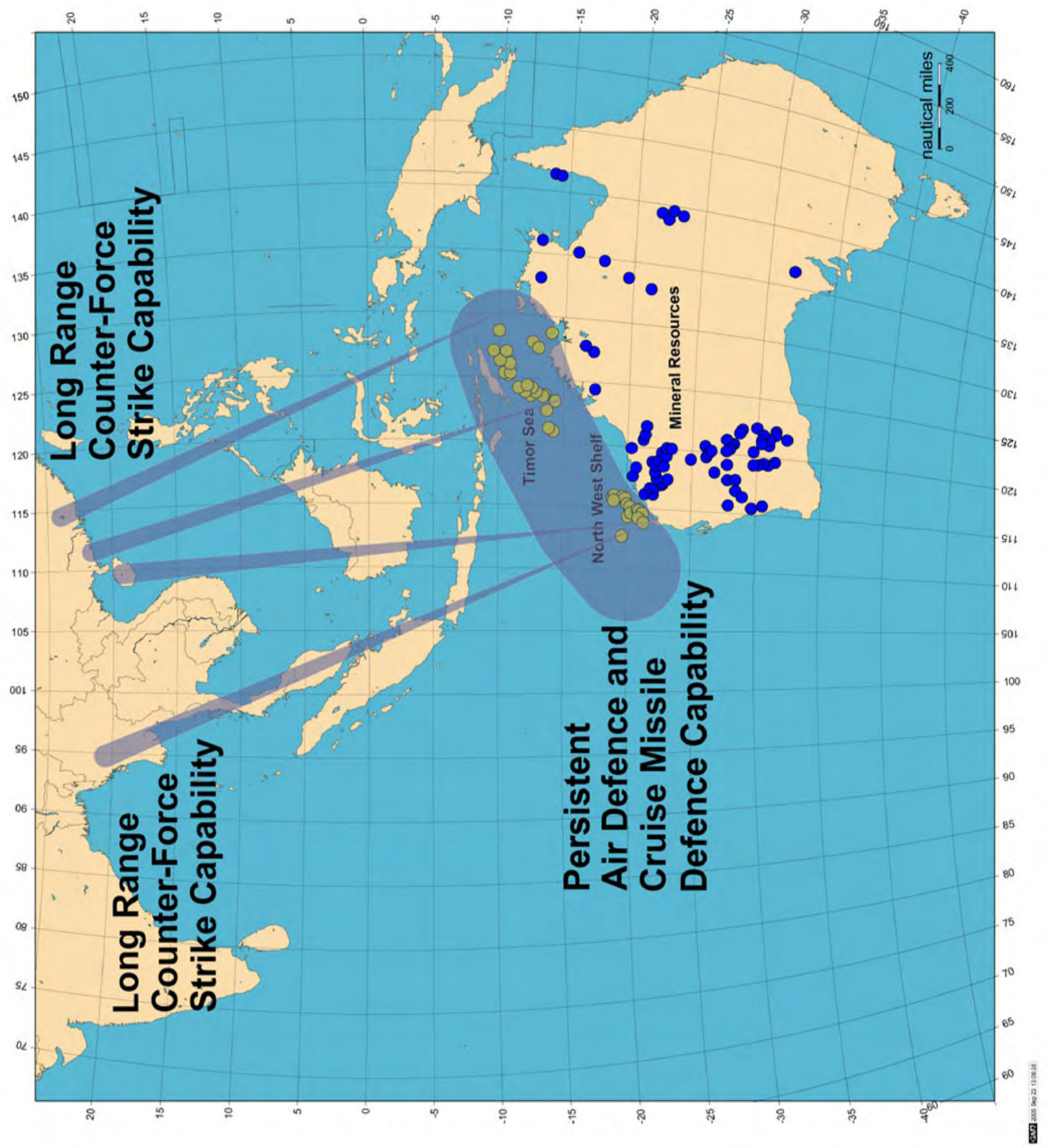

Figure 24: *This chart displays the air defence and long range strike capabilities required to effect credible regional deterrence, and to robustly protect key economic assets (C. Kopp).*

3 Achieving Air Superiority

This section explains the key factors which determine whether air superiority can be achieved, and the impact of underinvestment in key capabilities.

Air superiority is defined as the ability to achieve and maintain *control of the air*, which is the ability to conduct aerial operations without hindrance by an opponent, and the ability to deny the same to an opponent.

Air superiority is achieved by a combination of superior fighter aircraft, strike aircraft, weapons, surveillance aircraft, aerial refuelling tanker aircraft, as well as superior pilot ability and training.

Of all of the goals a defence force might aim to achieve in conflict, air superiority is by far the most difficult.

Without air superiority, an opponent can hold at risk or destroy air, land and naval forces, critical national infrastructure, industrial plant, and finally, aerial and maritime lines of communication. Air superiority is the precondition for all other military operations of significant scale[26].

Numerous good historical examples exist of air superiority being achieved, and of air superiority not being achieved:

- During the 1939 to 1940 period, Germany's Luftwaffe achieved air superiority over Poland, Holland, Belgium, Luxembourg, Norway and France. The result was a rout of opposing ground forces and an unprecedented defeat.
- During the Battle of Britain, neither side was able to achieve decisive air superiority, upon which Germany abandoned its daylight bombing campaign against Britain.
- During the invasion of the Soviet Union until 1943, Germany maintained air superiority over the Eastern Front. Once this was no longer sustainable, Germany's position collapsed.
- Japan achieved air superiority from the outset of the Pacific campaign, and only lost it in 1943, upon which Japan was driven into retreat.
- Germany lost air superiority over Western and Central Europe in the first half of 1944, as a result of allied deployment of long range fighter escorts. Germany collapsed twelve months later.
- The North Koreans and Chinese were never able to achieve air superiority over North Korea and suffered staggering losses to UN strike aircraft.
- North Vietnam, despite Soviet Bloc assistance in aircraft, missiles and pilots, was never able to achieve air superiority. Total losses to US air attacks were unprecedented.
- Israel achieved air superiority in the 1967 'six day war' as a result of a pre-emptive attack, and routed Egyptian and Syrian ground forces.

- Israel was unable to achieve air superiority in the opening days of the 1973 Yom Kippur war, and suffered heavy losses until the Israeli air force was able to gain the upper hand.
- Britain was unable to maintain air superiority during its 1982 campaign to retake the Falklands, despite the destruction of over 60 Argentinian aircraft. Britain lost four warships and two transports, while 55% of UK personnel lost were killed in air attacks.
- Israel's 1982 campaign in Lebanon saw a large pre-emptive attack to gain air superiority over Syria. As a result, Syrian forces were routed during the advance to Beirut.
- Libya was unable to maintain air superiority in 1986, as a result of which US F-111s and naval aircraft were able to attack a wide range of targets unhindered.
- The 1991 Desert Storm campaign saw US led coalition aircraft achieve air superiority within hours, following a pre-emptive attack. Iraq suffered enormous losses to air attack.
- Serbia was unable to maintain air superiority in 1999 and conceded its dispute over Kosovo after suffering heavy losses to air attack.
- Lacking an air force or air defence system of any substance, the Taliban were annihilated in 2001, mostly by air attack.
- Baghdad was overrun by Coalition forces in 2003 after three weeks of combat, as Iraq was unable to contest control of its airspace.

Sixty five years of modern conflict illustrate without ambiguity that those who can achieve air superiority prevail in conflict, and those who do not suffer accordingly, regardless of the scale, timing or location of the conflict.

It is important to observe that the last time Western military forces fought a major conflict without air superiority was during the opening phases of the Second World War, during which heavy losses were suffered as a result. The only recent instance since where a Western force fought without air superiority was during Britain's invasion of the Falklands, during which heavy losses in warships, transport vessels and personnel were sustained. The reality is that most Western militaries have no remaining corporate memory of fighting without air superiority, or of the heavy combat losses suffered as a result.

Figure 25: *Achieving air superiority requires that an air force outperforms its opponent in five key operational tasks - destroying enemy aircraft in the air, on the ground, defeating enemy airfields and electronic defences, and preventing the opponent from doing the same (C. Kopp).*

Figure 26: *Failure to perform in the five key operational tasks - destroying enemy aircraft in the air, on the ground, defeating enemy airfields and electronic defences, and preventing the opponent from doing the same - typically results in the loss of air superiority (C. Kopp).*

3.1 How is Air Superiority Achieved?

The achievement of air superiority is seldom an easy task, as most opponents are seeking themselves to gain air superiority in a conflict.

At the most basic level the contest for air superiority requires the destruction or denial of use of those assets which the opponent would use to gain air superiority.

Five operational tasks or activities are central to this contest:

1. *The opponent's aircraft must be destroyed in the air.* This is mostly accomplished by air combat fighters in aerial engagements. Ground based weapons such as surface to air missiles and anti-aircraft artillery can contribute, but are much less effective than fighter aircraft.

2. *The opponent's aircraft must be destroyed on the ground.* This is mostly performed by strike aircraft, using guided bombs, missiles, or cruise missiles. Cruise missiles launched by other platforms can contribute, but are typically much more expensive to deliver than guided bombs dropped by aircraft.

3. *The opponent's airfield infrastructure must be disabled or destroyed.* This is typically performed by strike aircraft, using guided bombs, missiles, or cruise missiles. The resilience of airfield infrastructure typically requires the use of weapons with greater effect than cruise missiles. In maritime conflict, sinking or disabling an aircraft carrier achieves this effect.

4. *The opponent's radar systems, communications and networks must be disabled or destroyed.* This is typically performed by strike aircraft, using guided bombs, anti-radiation missiles, or cruise missiles. Critical to situational awareness, such assets are often heavily defended.

5. *Critical air and surface assets must be protected from air attacks.* An opponent will seek to destroy or disable airfields, aircraft on the ground, radar systems, communications and networks, aerial tanker aircraft and airborne surveillance assets such as AEW&C aircraft. Therefore these must be protected from such attacks to preclude their loss in combat.

A great many historical case studies exist to illustrate this reality. Failure to succeed in any of these five critical activities can and usually does lead to a loss of air superiority, with dire consequences following.

1. *Failure to destroy the opponent's aircraft in the air contributes to unhindered air operations by the opponent.* An inability to effectively engage and destroy opposing fighters can result from a range of causes, but inferior fighter aircraft, weapons, pilot ability, and situational awareness are most prominent.

2. *Failure to destroy the opponent's aircraft on the ground contributes to unhindered air operations by the opponent.* An inability to achieve or sustain effective attacks on aircraft on the ground is usually a result of inadequate strike capabilities, given the defences to be overcome.

3. *Failure to destroy or disable the opponent's airfields contributes to unhindered air operations by the opponent.* An inability to achieve or sustain effective attacks on aircraft on the ground is usually a result of inadequate strike capabilities, given the defences to be overcome.

4. *Failure to destroy or disable the opponent's radar systems, communications and networks results in losses of combat aircraft.* As these systems are used to guide or cue fighters, surface to air missiles, anti-aircraft artillery, and in the future, directed energy weapons, their destruction is critical to crippling an opponent's defences. Lack of success is usually a result of inadequate strike capabilities, given the defences to be overcome, or inadequate air combat fighter capabilities, where the system is airborne.

5. *Failure to protect critical air and surface assets contributes to unhindered air operations by the opponent.* If an opponent can destroy or disable the key assets required to fight for air superiority, the battle is usually lost. This will arise typically as a result of inferior fighter aircraft, weapons, pilot ability, and situational awareness, the latter due to inadequacies in surveillance systems such as AEW&C aircraft or ground based radar.

Once an air force gains air superiority, and cannot be seriously challenged by opposing defences, it can swing its resources wholly to the task of destroying the opponent's surface assets.

Figure 27: *The loss of air superiority permits unhindered attacks on a wide range of targets. The depicted examples show examples of damage inflicted by air strikes between 1973 and 1999 (US DoD, misc sources).*

3.2 Consequences of Losing Air Superiority

Countless case studies exist of land armies and navies, and national infrastructure bases, suffering catastrophic losses to opposing air power, once air superiority is lost.

It is sobering to observe that such an outcome has been observed repeatedly since 1939 in high intensity and low intensity conflicts. Whether we consider the rout of the Western European armies in 1940, the destruction of the Japanese Imperial Fleet during the Pacific War, the wholesale demolition of German and Japanese industry in 1943 to 1945, the rout of Arab armies repeatedly since the 1950s at the hands of the Israeli Defence Force, or more recent examples such as the 1991 Desert Storm, 2001 Enduring Freedom and 2003 Iraqi Freedom campaigns, the pattern remains the same. Once air superiority is lost, the full force of air power is applied to demolish land armies, naval fleets and national infrastructure.

Whether such destruction achieves the military or political agendas of the attacker is immaterial, even if this issue remains the subject of ongoing debate. The key issue is that enormous material damage and loss of life can ensue. The scale of the latter is determined wholly by the targeting policies of the attacker, and to date only Western nations have accepted international law in this respect. Other nations could well adopt targeting policies which intentionally result in large civilian casualties, and numerous such examples exist.

Specific consequences of the loss of air superiority include:

1. Large scale destruction of air force assets including aircraft, airfields, fuel infrastructure, electronic communications infrastructure, radar infrastructure and other material assets used by an air force.

2. High tonnage losses in merchant shipping, including freighters, passenger transports, but especially oilers and tankers. Australia is especially vulnerable to interdiction of shipping as most exports and imports are transported by sea.

3. Sinking or serious damage to surface warships, aircraft carriers, amphibious ships and naval transports. The small size of the RAN surface fleet results in a low capacity to absorb such attrition in combat.

4. Destruction of ground forces, including armoured vehicles, support vehicles, fixed infrastructure and personnel. The small size of the Army results in a low capacity to absorb such attrition in combat.

5. Destruction of road and rail communications. Australia has little redundancy in road and rail communications in the north, increasing the impact of any such damage.

6. Destruction of industrial plant, ports, railway yards, petrochemical plant and other industrial facilities. Australia's dependency on export revenues from resources increases significantly the impact of damage to such assets, especially those in the north and north-west of Australia.

A great many examples exist to illustrate this point, spanning a period between 1939 and the present, and observing that bomber and Zeppelin raids during the Great War accounted for considerable loss of life and materiel as well.

It is critically important to consider the impact of technological evolution over recent decades in assessing the damage which can arise from a loss of air superiority.

Since the mid 1980s we have seen two key developments. The first is the growth in sensor capabilities of strike aircraft. Today production strike aircraft, be they Western or Russian, are equipped with radars capable of producing very high resolution ground maps, and capable of tracking even small moving ground targets such as 4 wheel drives and cars[27].

Thermal imaging targeting systems allow strike aircraft to see, day and night, even the smallest surface targets, by sensing and imaging heat emissions. Well publicised during the 1991 Gulf War, thermal imagers are now widely available for combat aircraft, including Russian types.

The second key development is the proliferation of precision guided munitions, or smart bombs and missiles. Such weapons have many times the lethality of unguided or dumb weapons, and thus permit a single strike aircraft to produce vastly more focussed and lethal damage effects than the massed heavy bomber formations of decades ago. Media exposure has created the false impression that smart weapons are exclusively a US technology. At this time smart weapons are being actively exported by the US, EU, Israel and Russia. Russian smart munitions are mostly direct equivalents to their US competitors, and often provide additional capabilities.

The consequence of this evolution, and proliferation, is that the style of precision all weather air and cruise missile attack pioneered by the US will be a capability common in this region, with the scale of the attack determined wholly by the nation in question and how much it has invested in modern combat aircraft and smart weapons warstocks. The exclusivity enjoyed by the United States and Australia in these capabilities, regionally, is now a thing of the past.

In strategic terms Australia's small population base and small industrial base, by regional standards, makes it imperative that Australia retain the capability to achieve and maintain air superiority over any regional opponent which may choose to violate Australian territorial geography, or Australia's regional interests. Australia can afford to compromise in its Army and Navy capabilities, but it cannot afford to compromise in Air Force capabilities. Inadequate Air Force capabilities would impact the nation's long term strategic position to the extent, that Australia would lose its capacity to make its own strategic choices in this region.

3.3 Planning Force Structure to Achieve Air Superiority

For an air force to be successful in achieving air superiority against a given opponent, it must have suitable capabilities. Improper choices in planning can and usually do result in unsuitable types of combat aircraft, with inappropriate numbers in operation.

Much is often made of the issue of aircrew proficiency and indeed talent, as a key factor in an air force's capability to achieve air superiority. Historical experience indicates that aircrew abilities are important, but are not a substitute for suitable combat aircraft in appropriate numbers. The unavoidable reality, demonstrated repeatedly since 1914, is that the performance and capabilities of combat aircraft used is the dominant factor in determining success in aerial combat. In simple terms, there is no substitute for having more capable and better performing fighter aircraft.

Regional defence forces present modern capabilities and force structure models increasingly influenced by the US model. Regional air forces are likely to possess many or all of the following capabilities:

1. High capability category air superiority fighters such as the Russian Su-27/30 Flanker, or the US F-15.
2. An Airborne Early Warning and Control system, of Russian, Chinese, Israeli or US origin.
3. Aerial refuelling tanker aircraft of Russian or US origin, in the future likely also of European or Israeli origin.
4. Modern guided bombs and missiles of Russian, Israeli, European or US origin.
5. Modern air and sea launched cruise missiles of Russian or Chinese origin.
6. Multirole or dedicated strike aircraft with precision guided munitions capability, of Russian, Chinese, European or US origin.
7. China is likely to operate strategic bombers of Russian origin.
8. Reconnaissance and surveillance capabilities including satellite imaging, radar ocean satellite surveillance, fighters with reconnaissance equipment, electronic and signals surveillance aircraft, and in the future, long endurance unmanned aircraft.
9. Support jamming aircraft equipped to disrupt Airborne Early Warning and Control radars, surface based radars, communications and networks, this equipment of Russian or Chinese origin.

Should a conflict develop in the region, it is more likely that less likely that the ADF would have to confront the full spectrum of capabilities used to fight for air superiority. As a result there are no real shortcuts available in developing and maintaining the RAAF's force structure.

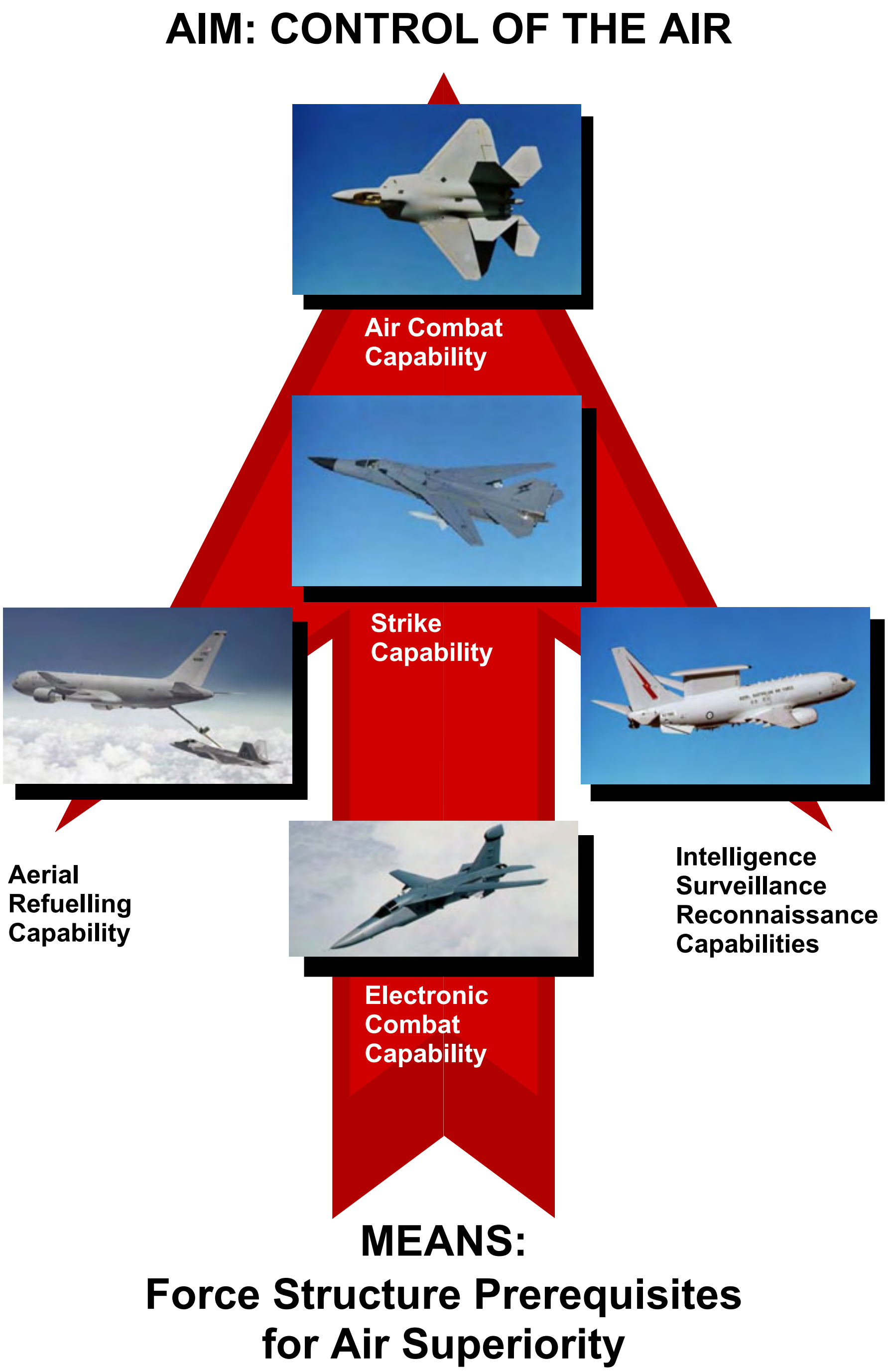

Figure 28: *Force structure prerequisites for achieving air superiority. It is important to observe that recent air campaigns, such as Desert Storm, Allied Force, Enduring Freedom and Iraqi Freedom were all 'asymmetric' in the sense that opponents of US led coalitions lacked most if not all of these capabilities in their force structures. Where a 'symmetric' situation exists, superior capability in most if not all of these capabilities is required to prevail in combat. Superior capability in all of these areas is the only way to ensure that Air Superiority can be assured by a properly resourced, trained and prepared force. Shortfalls in any of these areas increase the risks that such an equipped force will be defeated. Equipping such a force is a typically 15 to 20 year iteration. (C. Kopp).*

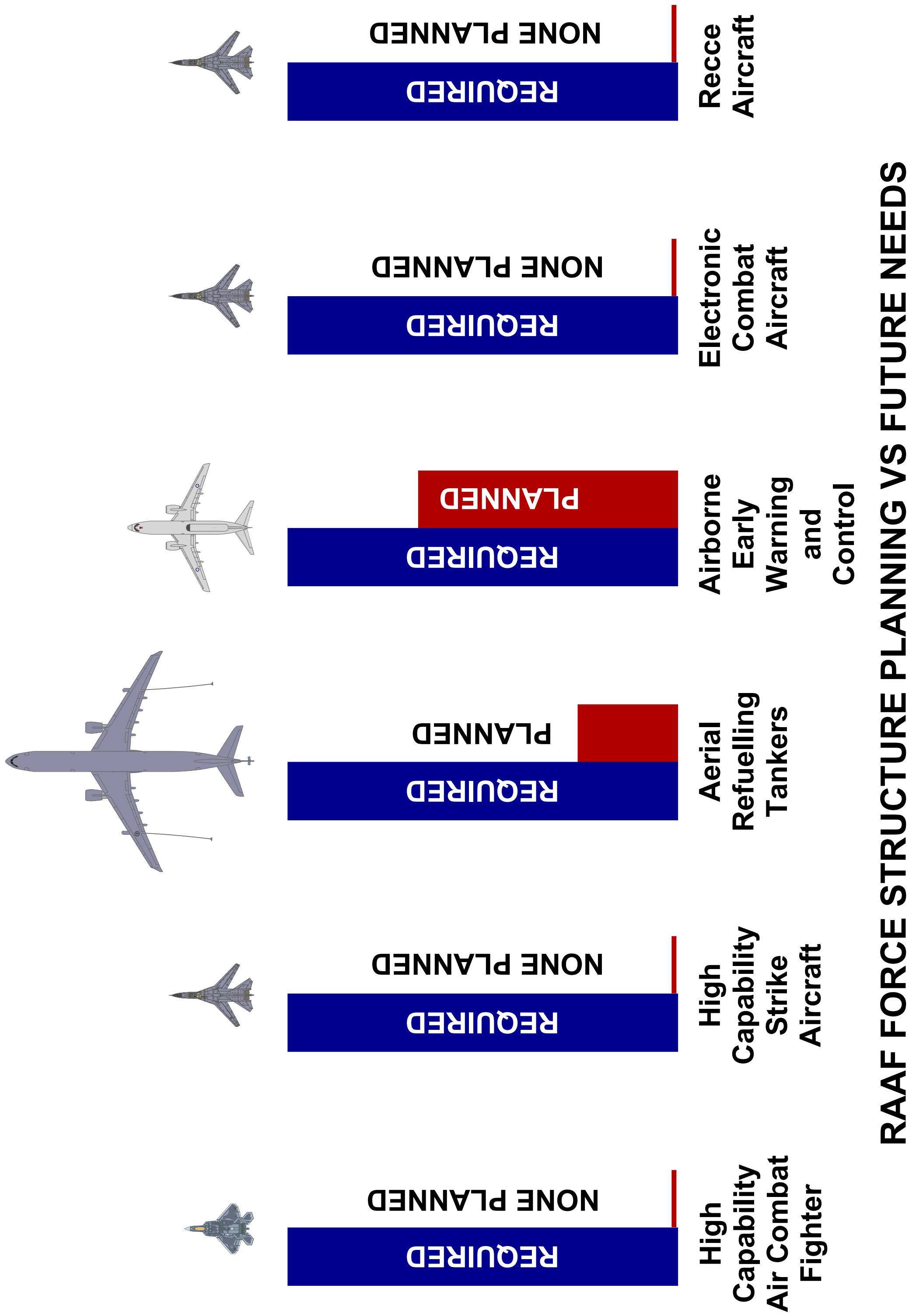

Figure 29: *This chart displays planned RAAF force structure investment vs needs arising from regional capability growth. Of the six key areas of investment, two involve inadequate investment and four no investment at all (C. Kopp).*

Force Structure Model for Air Superiority

Type	Number	Unit	Category
F-22A Raptor	50	3, 75, 77 SQN, 2 OCU	Tactical Fighter, Air Combat
F-111S	36	1, 6 SQN	Tactical Fighter, Strike Recce
Wedgetail	8	2 SQN	AEW&C
EP-8A	4	2 SQN	SIGINT/ELINT
AP-3C	12	11 SQN	ISR, LRMP
RQ-4B Global Hawk	12	10 SQN	ISR, LRCR
KC-747-400	12	33 SQN	AAR/SAL
A330-200	5	33 SQN	AAR/SAL

Table 3: Force structure model designed to ensure air superiority in the future regional environment, excluding wideband electronic attack, dedicated airlift and training capabilities, and attrition aircraft. This table details the results of more than five years of research aimed at solving this capability need.

Category	Roles and Missions
Tactical Fighter, Air Combat	Air Superiority, Air Defence, Precision Strike, Cruise Missile Defence, Reconnaissance
Tactical Fighter, Strike Recce	Precision Strike, Battlefield Strike, Maritime Strike, Imaging Reconnaissance, Cruise Missile Defence
AEW&C	Airborne Early Warning and Control
SIGINT/ELINT	Signals and Electronic Intelligence
ISR	Intelligence Surveillance Reconnaissance
Electronic Attack	Radar, Communications, Network Jamming
LRMP	Long Range Maritime Patrol
LRCR	Long Range Communications Relay
AAR	Air to Air Refuelling
SAL	Strategic Air Lift

Table 4: Force structure model categories. While two multirole tactical fighter categories are defined, each can assume specialised tasks where its capabilities are better suited.

> The ADF has no choice, if the intent is to maintain Australia's strategic position in this region, than to properly develop the full spectrum of capabilities for achieving and maintaining air superiority, in credible numbers. Any other approach to this problem creates significant medium and long term weaknesses which will leave Australia at a disadvantage in the regional strategic context.

Australia will have to invest in all of the key capabilities required to achieve air superiority:

1. A high capability category air combat fighter capability, rather than the low capability category small fighters operated since the 1940s.
2. A high capability category strike capability, enhancing the capability currently provided by the F-111.
3. A robust aerial refuelling fleet in numbers matched to the numbers of combat aircraft, in a ratio of at least one medium sized tanker aircraft per four combat aircraft.
4. Robust Airborne Early Warning and Control capability, in greater numbers than the currently planned six aircraft.
5. Robust capability for imagery intelligence, other than satellite imagery, with sufficient capacity to support combat operations in the areas of interest.
6. Robust capability for electronic and signals intelligence gathering, with sufficient capacity to support combat operations in the areas of interest.
7. Robust capability for electronic combat, using support jamming aircraft, with sufficient capacity to support combat operations in the areas of interest.
8. Robust capability to support aircraft, systems, weapons, infrastructure, both deployed and at permanent basing.
9. Fuel storage and replenishment infrastructure at northern Australian bases to sustain a credible rate of effort using all RAAF combat aircraft, aerial refuelling tankers and other supporting assets.

It is necessary to include airfield fuel replenishment infrastructure to essential prerequisites to achieve air superiority. Where insufficient capacity exists to replenish consumed aviation fuel, the air force using these facilities will be severely limited in how many sorties it can fly. The useful size of the force would be limited by the fuel replenishment infrastructure rather than the number of aircraft in service.

The need for a high capability category air combat fighter capability derives from the simple reality that most regional operators are acquiring high capability category air combat fighters, specifically the Sukhoi Su-27/30 series and the Boeing F-15. Indeed, within the region only Australia, New

Figure 30: *Upper - The only two non-Russian high capability category air combat fighters in production are the legacy F-15 (foreground) and its replacement, the F-22A (background). Lower - Australia already has a high capability category strike capability in the F-111. Unlike the United States, which plans to operate the older B-52H bomber and technologically similar B-1B bomber until 2040, current planning in Australia is to retire the F-111 without equivalent replacement in 2010 (US Air Force).*

Zealand, Bangladesh, Burma and Taiwan neither operate nor plan to operate a high capability category air combat fighter capability.

At this time there are only three high capability category air combat fighter designs in production - the Sukhoi Su-27/30, the legacy Boeing F-15 and the Lockheed-Martin F-22A Raptor.

> High capability category air combat fighters are characterised by the best aerodynamic performance possible from the available technology base, as well as the most powerful radars and other sensors available. This trend has existed since the Great War, and has always seen major powers push the envelope of technology to provide the most capable designs achievable.

The Boeing F-15 Eagle has been in production since the 1970s and remains the most numerous US built high capability category fighter globally. The Sukhoi Su-27SK was developed during the 1970s as a counter to the F-15, and outperforms the F-15 in many key parameters. The Lockheed-Martin F-22A was developed to replace the legacy F-15, and adds important new capabilities such as all aspect stealth, supersonic cruise and advanced radar and avionics.

Low capability category air combat fighters are only produced by the Europeans at this time, in the Eurofighter Typhoon and Dassault Rafale. The US is manufacturing the F-16E and F/A-18E/F, both of which were originally developed during the 1970s as low cost low capability category air combat fighters, but both of which no longer have the performance to be credible against opponents such as the Sukhoi Su-27 and Su-30 series, thus shifting their primary use to bombing. The Joint Strike Fighter is being developed primarily as a small bomber to support ground forces over the battlefield, and is expected to at best match the performance of the legacy F-16 and F/A-18 designs.

While all modern fighters are now built as multirole aircraft, capable of delivering smart bombs against surface targets, what distinguishes air combat fighters is their high performance and long range radar capability.

> High capability category strike aircraft, like high capability category air combat fighters, are designed to the limits of the available technology, to maximise speed, range and weapon carrying capability. Such aircraft typically carry twice the weapon load of smaller multirole fighters, usually to almost twice the distance. The F-111 is a good example, providing a capability equivalent to a pair of F/A-18s or Joint Strike Fighters, the latter supported by one or more aerial refuelling tankers.

In terms of maintaining a high capability category strike capability, Australia already possesses such a capability in the F-111 fleet. At this time there is only one high capability category strike aircraft in production, the Russian Sukhoi Su-34 Fullback, derived from the Su-27 Flanker. The US Air Force is tentatively planning for the new FB-22A after 2015, but at this time no significant funding has been made available to develop this F-111-sized enlarged derivative of the F-22A Raptor. The FB-22A would be an exact replacement for the F-111 but remains at this time a paper design.

Figure 31: *Aerial refuelling tankers are the critical enabler for fighter aircraft. In practical terms the number of fighters usable in most combat situations is determined by the number of aerial tankers available, rather than fighters on the flightline. In situations where range and endurance matter, such as Australia's north, heavy tankers are more suitable than medium sized tankers, such as the A330-200 ordered for the RAAF. Upper - US Air Force KC-10A heavy tanker, lower - prototype ACTA heavy tanker based on the 747 (US Air Force).*

Aerial refuelling is the critical enabler for modern air power, providing both range and persistence in combat. The practical reality is that in Australia's geography, the number and size of available tankers sets hard limits on how many fighters can be used effectively in combat. Whether Australia deploys 60, 80, 100 or 130 fighters, the range and endurance limitations of these fighters means that only the number for which aerial refuelling support is available can perform tasks other than defending the immediate vicinity of their home base.

Statistical analysis of air campaigns since the 1960s, as well as extensive mathematical and computer modelling, indicate that a single medium sized tanker, in the size class of the KC-135R, KC-767 or A330-200MRTT can typically support between two and six fighters in combat operations. Larger tankers, such as the KC-10A or KC-747-400 can support roughly twice as many fighters, due to much larger fuel payloads.

There is no substitute for aerial refuelling tanker aircraft, and the notion that a modern air force can be operationally viable with a token number of tanker aircraft is demonstrably no more than wishful thinking.

The notion that Australia can always rely upon the provision of US aerial refuelling tankers in a crisis is not credible, given the significant budgetary pressures the US Air Force is currently being subjected to, especially in funding recapitalisation of the existing US tanker fleet.

No less importantly, heavy tanker aircraft such as the KC-747-400 can address other vital needs for the ADF, such as strategic airlift, if acquired in suitable numbers. The acquisition of twelve or more dual role 747 derivative tankers to provide a full strength tanker and strategic airlift fleet is both technically feasible, and affordable, but to date has not been adopted in planning.

Airborne Early Warning and Control aircraft are critical enablers in operations aimed at achieving air superiority. These aircraft combine a high power long range radar, passive electronic surveillance sensors, comprehensive digital and voice communications, networking equipment, and a battle management staff to control fighter operations. Airborne Early Warning and Control aircraft provide situational awareness over a radius in excess of 200 nautical miles.

Australia's Wedgetail AEW&C system is the most sophisticated design yet to be deployed, and sits ahead of the US Air Force's E-3C AWACS by a generation of radar technology. Australia currently plans to field six aircraft, which provides a limited capability. A genuinely robust force structure would have eight to nine aircraft, to provide coverage for three areas of operations and sufficient redundancy to cope with aircraft unavailability.

It is important to distinguish the very different functions of the Wedgetail AEW&C system, against the Jindalee Over The Horizon Backscatter (OTH-B) high frequency radar system (JORN). JORN provides long range wide area surveillance, but lacks the precision and high rate tracking capabilities of the Wedgetail AEW&C system, and its passive surveillance and battle management capability.

Figure 32: *Intelligence, Surveillance and Reconnaissance capabilities are an area of ongoing under-investment in Australia. The Wedgetail AEW&C (upper, centre) may well be the most advanced globally, but Australia is acquiring only six aircraft. Australia currently has a very limited capability for airborne signals and electronic intelligence gathering. Depicted is a Boeing EP-8A proposal, intended to provide comprehensive networked gathering and analysis of voice and data communications, network signals and radar signals (Boeing, C. Kopp).*

Figure 33: *At this time Australia has no plans to acquire a ground target surveillance and tracking radar system with capabilities like the US E-8C JSTARS (upper). While acquisition of the RQ-4 Global Hawk (centre) has been canvassed publicly in Australia, it is unlikely that adequate numbers would be acquired to cover both maritime patrol and combat ISR needs. Such systems can produce high resolution terrain maps and track moving ground vehicles (lower), in real time (US Air Force, Northrop-Grumman).*

Figure 34: *Australia currently has no plans to acquire an electronic combat or attack capability, despite the proliferation of advanced radar, communications and networking systems across the region. The option of refurbishing and upgrading mothballed surplus EF-111A Raven electronic combat aircraft remains open as long as Australia operates the F-111 (upper). Russia is reported to be developing an electronic combat system, based on the Sukhoi Su-34 Fullback bomber (lower). The Fullback entered production in 2004 (US Air Force, Sukhoi).*

Therefore JORN and the Wedgetail AEW&C system are complementary.

While Wedgetail provides radar and some passive electronic surveillance, it represents only one of three core capabilities for Intelligence, Surveillance and Reconnaissance (ISR).

> Imaging and electronic Intelligence, Surveillance and Reconnaissance capabilities provide the means of establishing what the opponent's activities, deployment and capabilities are. Without these capabilities it is extremely difficult if not impossible to determine what the opponent's strength is, and what activities they are pursuing at any given time. All deployable imaging and electronic Intelligence, Surveillance and Reconnaissance systems combine a sensor package to gather information, and vehicle to deploy the sensor package. Such vehicles can be aircraft, uninhabited aerial vehicles or satellites in orbit.

It is important that Australia has to date invested very poorly in imaging and electronic Intelligence, Surveillance and Reconnaissance capabilities. While some electronic Intelligence, Surveillance and Reconnaissance capability exists in the Wedgetail, the AP-3C Orion, and some modified AP-3C and C-130 signals intelligence aircraft, Australia lacks any specialised and dedicated system comparable to the US RC-135V/W Rivet Joint, EP-3C Aries, EP-8A, the UK's Nimrod R.1, or Israeli, European, Russian or Chinese equivalents.

Australia's only genuine imaging Intelligence, Surveillance and Reconnaissance capability resides in four RF-111C aircraft equipped with 1960s technology wet film camera systems. Australia has experimented with the DSTO Ingara high resolution imaging radar system, but has no plans to acquire a substantial capability in this area, comparable to the US E-8 JSTARS, E-10 MC2A, UK ASTOR Sentinel R.1 or European equivalents.

> While much has been said about the adoption of networking and the 'system of systems' model, unfortunately this model only works properly if there is an abundance of Intelligence, Surveillance and Reconnaissance capabilities to feed digital data into the network. A networked 'system of systems' which is starved of data from Intelligence, Surveillance and Reconnaissance system sensors is effectively deaf and blind.

The notion that Australia can largely rely upon US Intelligence, Surveillance and Reconnaissance products is simply not realistic, unless Australia is only ever engaged in coalition operations with the US.

US satellites have global tasking, and retasking them to address time critical Australian needs could prove very difficult in a crisis. Moreover, optical imaging satellites cannot penetrate cloud cover, and with all satellites, timeliness of product depends on orbital position. While satellites can provide valuable product, they can only address part of the capability need.

Long endurance Uninhabited Aerial Vehicles (UAV), such as the RQ-4 Global Hawk, provide many capabilities similar to satellites, and many which are unique to such UAVs, such as the ability to

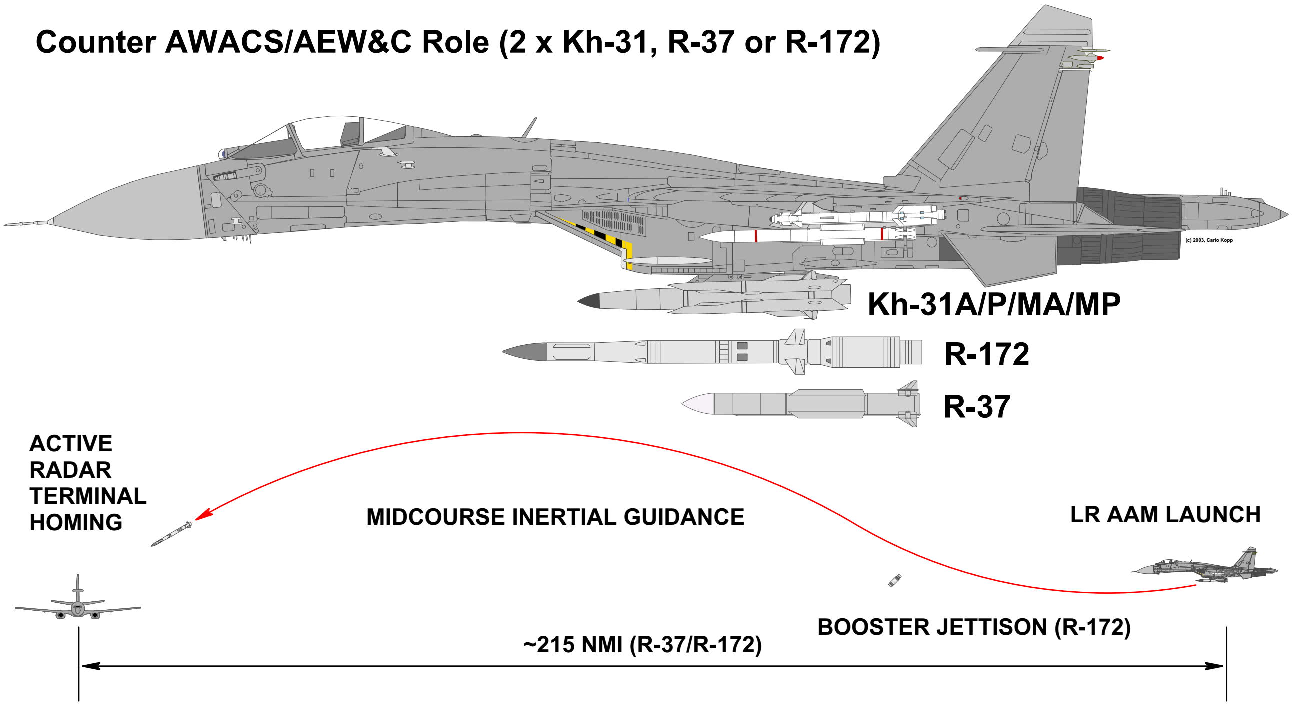

Figure 35: *The importance of Intelligence Surveillance Reconnaissance capabilities is so great, it has resulted in the evolution of specialised weapons and tactics to disrupt and destroy such systems. Russia is actively marketing very long range missiles for this purpose within the region. Without a high capability category air superiority fighter which can intercept such threats very early, high value assets like the Wedgetail are at risk (C. Kopp).*

persistently orbit in an area of interest for many hours. Such UAVs fly high enough to defeat many fighter aircraft and surface to air missile defences, but not all such defences. Another consideration is that such UAVs rely heavily on communications satellites to transfer imagery product to user ground stations, which will impose some limitations in capability.

An idea which has been widely propagated in Australia is that the internal sensor package in the Joint Strike Fighter can be used to provide critical imaging and electronic Intelligence, Surveillance and Reconnaissance capabilities. This argument is not credible, given the limited surveillance footprint and resolution of the these sensors, compared to specialised and dedicated sensors built for Intelligence, Surveillance and Reconnaissance platforms.

> If Australia has any future intention of conducting independent military operations in the region, and achieving air superiority in a regional conflict, significant investments need to be made in both imaging and electronic Intelligence, Surveillance and Reconnaissance capabilities. Networking systems without adequate supporting Intelligence, Surveillance and Reconnaissance capabilities is not a credible solution to this problem.

While the ability to surveil and analyse an opponent's electronic sensor, communications and networking capabilities is vital in combat, it alone does not confer the capability to deny an opponent the use of these capabilities. That is the role of electronic combat capabilities.

> Electronic combat or electronic attack capabilities, comprising the ability to surveil, track and jam an opponent's radar, voice communications and networking, are critical capabilities in modern conflict. In recent conflicts the US has used this capability to not only jam the systems used by opponents with modern capabilities, but also to jam battlefield radio communications used by the Taliban, Al Qaeda and Iraqi insurgents. Importantly this capability has been a key feature of every significant conflict involving air power since the 1940s, and not uniquely a US capability, as demonstrated by the Israelis and Soviets.

Australia has never operated aircraft equipped with high power jamming equipment. US approaches during the mid to late 1990s, offering surplus US EF-111A Raven jamming aircraft, were not received with any official interest in Australia, despite the high combat value of these systems.

With the advent of modern capabilities like Airborne Early Warning and Control, digital networking, advanced radars and missiles across this region over the last decade, the notion that electronic combat capabilities are an 'overkill' is no longer true. These capabilities are now becoming essential to achieving success in any conflict involving modern capabilities. Indeed, Russia is developing such a capability to be carried by the Sukhoi Su-34 Fullback aircraft, and regional nations will be the primary export target for such a system.

> Provision of the full suite of operational capabilities required for air superiority may not produce the intended effect, if these capabilities are not properly supported, both by organic service support capabilities, and broader and deeper industrial base capabilities. Australia has seen a considerable reduction in such capabilities both within the ADF, and across the industry, over the last decade. Unless this trend is reversed, a shortage of technical, engineering and analytical skills will severely impact the future ability of the RAAF to maintain, upgrade and adapt what capabilities it does possess.

While a number of causes have contributed to the current decline in the support base, notable contributing factors include the realignment of RAAF engineering into logistics over a decade ago, focussing skills away from technical to management, often poorly managed outsourcing, which depleted service skills without providing a replenishment mechanism via training, and ongoing difficulties with the retention of highly experienced and trained personnel. These factors arise in confluence with a decline in many key areas of the industrial skills base.

It is important to observe that air power is a technologically centred capability, where the ability to use machines in combat is the determinant of capability and operational success. Historical case studies repeatedly show that problems or limitations in the technological support base, but also the pool of technological knowledge and understanding within a service, can have a critical impact on immediate operational capabilities, but also the ability to understand developing trends and successfully plan for the future.

The current trend to deskilling observed in the RAAF and many applicable sectors of industry must be reversed in coming years, to ensure that the RAAF has the capability to support its force, but also adapt and modify systems at short notice, and perform accurate analyses of technological problems related to capability.

The final capability element required to achieve air superiority in a regional context is that of sufficient aviation fuel replenishment capability for Australia's northern chain of airfields, especially RAAF Learmonth and Tindal.

> It takes very little analysis to establish that a deployment to northern bases of most of the RAAF's combat aircraft, supporting assets such as the Wedgetail, appropriate numbers of tanker aircraft, and subsequent intensive flight operations commensurate with an effort to achieve air superiority over the north and northern approaches, would result in the daily consumption of up to 3,000 tonnes of aviation fuel per day. Current storage and fuel replenishment capabilities cannot credibly sustain such a rate of effort.

Moreover, the limitations of existing replenishment capabilities would preclude the effective deployment of a US Air Expeditionary Force even should Australia opt to wholly rely on US capabilities for air superiority.

These limitations in infrastructure exist despite the very modest costs of additional fuel storage, and pipelines to offshore jetties, or at Tindal, a railway siding at Katherine on the new Alice Springs to Darwin railroad. Of all of the capability limitations Australia has in using what air power it has, the problem of aviation fuel replenishment infrastructure is the least expensive to solve.

3.4 Why the Joint Strike Fighter is Unsuitable for Australia

The most important single force structure planning decision the ADF faces over the next half decade is in its choice of aircraft to replace the capabilities in the current F/A-18A and F-111. Current planning envisages the Joint Strike Fighter as a single type replacement for all RAAF combat aircraft.

> The Joint Strike Fighter is not a suitable replacement aircraft, given regional capabilities which have developed since 1991, and continue to develop. The Joint Strike Fighter cannot credibly fill the diversity of roles which the F/A-18A and F-111 performed successfully over recent decades.

To appreciate the extent to which the Joint Strike Fighter cannot fit Australia's needs, it is necessary to explore measures used to assess the capabilities of air superiority fighters and strike aircraft.

With decades of experience accrued in the development and combat operation of air superiority fighters, identifying capabilities and performance measures which are required for success is not unusually difficult.

For a contemporary air combat fighter, these measures can be summarised as:

1. **Speed** - what speeds can the fighter sustain for short and extended periods of time. Speed is important since it provides the ability to close distance, or gain separation, from an opponent faster. Slower fighters typically cede the initiative to faster fighters.
2. **Agility** - agility is a measure of the fighters ability to manoeuvre, especially its ability to turn or climb. Agility is most important in close combat.
3. **Combat Persistence** - combat persistence is a measure of how long a fighter can sustain combat speeds and accelerations before it exhausts its onboard fuel and is forced to disengage. In general, the greater the combat persistence of a fighter, all else being equal, the better its odds of winning an engagement.
4. **Weapons Capability** - weapons capability is defined by the types and number of guided missiles a fighter can carry. In addition, most fighters carry a gun for close combat, and directed energy weapons are a future likelihood.
5. **Radar Footprint** - radar footprint is a measure of what area a fighter's radar can surveil. Footprint is important since it is measure of the fighter's ability to autonomously locate and engage targets.
6. **Passive Sensor Capabilities** - passive sensors allow the fighter to detect an opponent without emitting a radar signal. Such sensors include infrared trackers and passive radar homing and warning receivers.
7. **Stealth** - stealth is a measure of how small the fighter's radar and heat signatures are, and determines the distance at which a opponent can detect and engage the fighter. A fighter

with the radar signature of a golfball will be harder to detect than a fighter with the signature of a beachball.

8. **Core Avionics** - core avionics are the internal suite of computers and supporting hardware and software which manage the fighter's systems. The more computing power, and capacity for growth in computing power, the better.

9. **Networking Capabilities** - networking capabilities encompass not only the digital radio modems used for networking, but the supporting software which allows the fighter to manage and distribute information gathered by other platforms, and its internal sensors.

The first four of these measures are 'kinematic' and related to the fighters ability to quickly position itself to defeat its opponent. The remaining four measures are related to the fighter's ability to gather, exploit, distribute and deny information during an engagement. With the exception of high performance stealth, all of these measures can usually be retro-fitted to older designs.

For a fighter to be successful across the full spectrum of air combat engagements it is likely to confront, it must be capable of bettering its opponents in all or most of these measures. The narrower the margin in capability advantage, the greater the impact of pilot ability, training, operational technique and numbers become.

> The notion that a fighter with inferior aerodynamic performance and weapons capabilities can prevail over a fighter with superior aerodynamic performance and weapons capabilities by virtue of networking capabilities and avionics is not rational. Indeed, it is reminiscent of a widely held belief during the early 1960s that inferior fighters equipped with guided missiles could prevail over superior fighters without missiles. Numerous air battles during the 1960s proved this idea completely wrong. Periods of large technological change seem to be accompanied by the proliferation of unsound ideas of this ilk - until combat proves them to be wrong.

The Joint Strike Fighter is not being designed primarily as an air superiority fighter, but as a small bomber with a respectable capability for self defence. The primary role for the Joint Strike Fighter is supporting ground troops and destroying an opponent's battlefield assets. How well the Joint Strike Fighter can fulfil this primary role, given ongoing development problems, remains to be determined.

What air combat capability and stealth capability the Joint Strike Fighter has is predicated on the assumption that it will mostly be flown as a bomber, evading enemy fighters rather than engaging them. Therefore the aerodynamic performance of the Joint Strike Fighter is being designed around the performance achieved by the ageing F-16C and F/A-18 fighters, both used primarily as small bombers in recent conflicts.

It is useful to test the capabilities of the Joint Strike Fighter against the most likely adversary aircraft it would encounter in this region, an advanced derivative of the Russian Sukhoi Su-30 or Su-35 series, refer Figure 37. Clearly the Joint Strike Fighter falls short on almost all key measures, other than stealth.

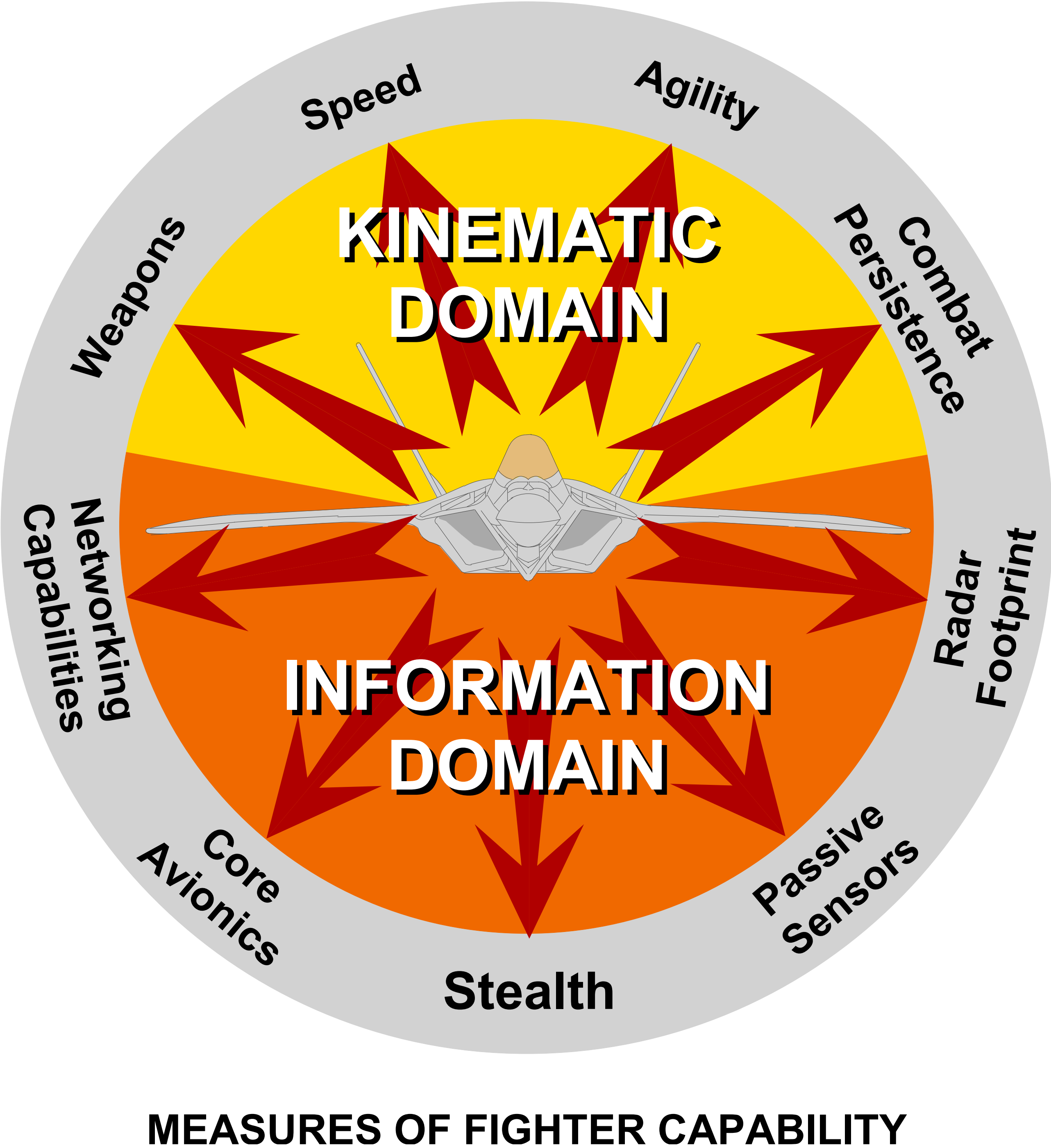

Figure 36: *Decades of experience in modern air combat allow us to identify nine key measures of fighter capability. Four of them fall into the 'kinematic domain' and afford the superior fighter the ability to gain a positional advantage over an opponent, while five of them fall into the 'information domain', and afford the superior fighter an advantage in situational awareness. Shortfalls in any of these nine areas can be decisive in combat (C. Kopp).*

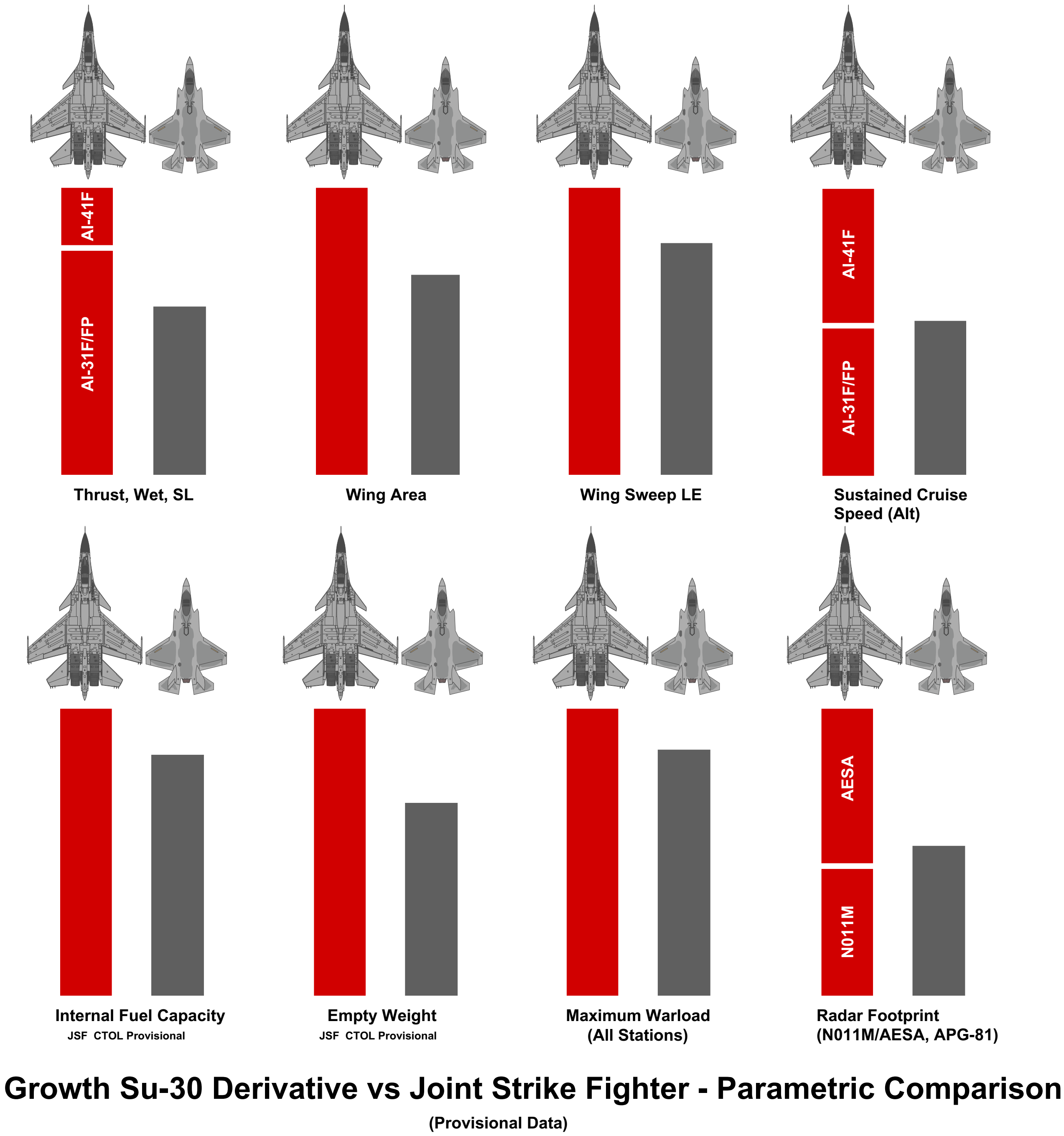

Figure 37: *This chart compares cardinal performance and capability parameters of the Joint Strike Fighter against baseline and growth variants of the Russian designed Sukhoi Su-27/30 family of fighters. Russian sources claim that a growth variant with the supersonic cruise capable AI-41F engine entered flight test in 2004, an AESA radar is in development. Against the baseline Su-27SMK/Su-30MK the Joint Strike Fighter is competitive only in radar performance, against the growth variant is it wholly outclassed (C. Kopp).*

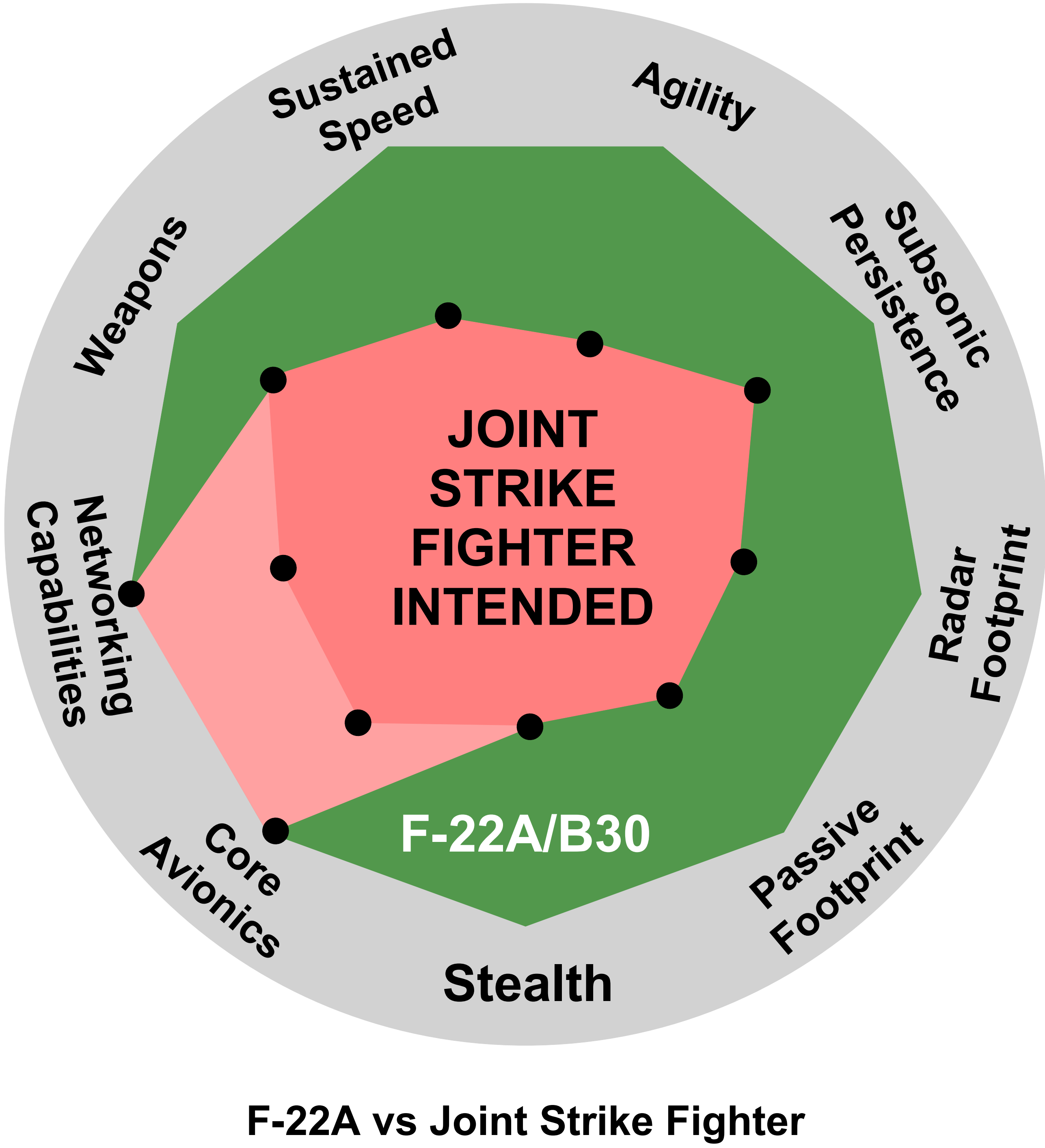

Figure 38: *Comparison of cardinal capability measures for the F-22A and the Joint Strike Fighter. While the intended Joint Strike Fighter capability matches the networking and internal computing capabilities of the F-22A, the Joint Strike Fighter falls short in its capabilities to detect targets and threats, its stealth, and its kinematic performance is in the class of a basic third generation fighter. This reflects the reality that the Joint Strike Fighter was devised as a 'small bomb truck' to support ground forces on the battlefield, rather than defeat opposing air power (C. Kopp).*

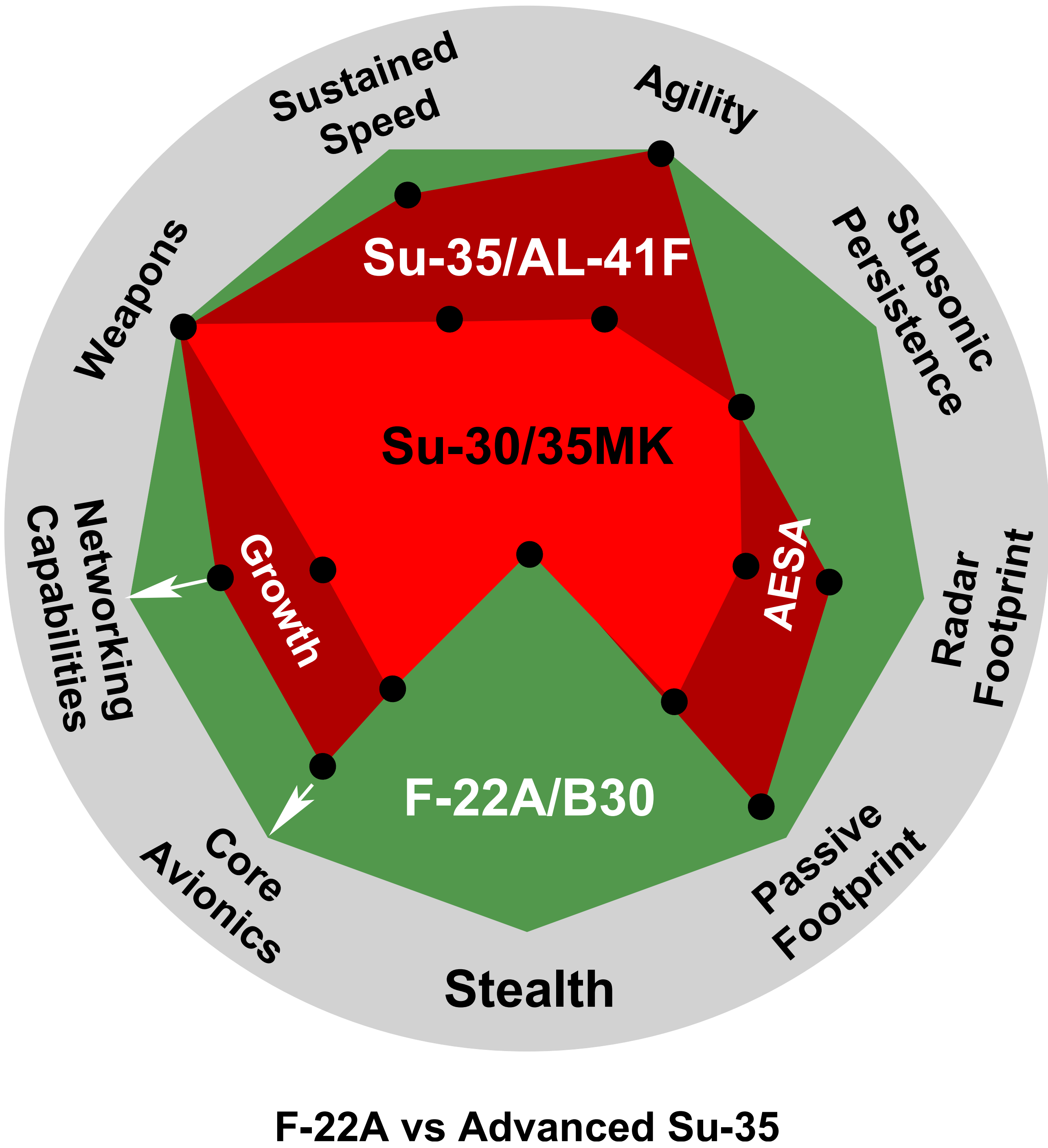

Figure 39: *Comparison of cardinal capability measures for the F-22A and advanced variants of the Sukhoi Su-30MK and Su-35. The basic Su-30MK and Su-35 can be enhanced via the installation of AL-41F supersonic cruise engines, the installation of an active phased array radar (AESA), and the enhancement of core avionics and networking using commercial computing hardware. With these enhancements the Sukhoi approaches the kinematic performance of the F-22A and its target detection footprint, but falls short in stealth, networking and avionics capabilities (C. Kopp).*

In practical terms the Joint Strike Fighter is best equipped to evade the Sukhoi rather than fight it. This contrasts strongly against a comparison between the F-22A Raptor and the Russian Sukhoi Su-30 or Su-35 series, where the F-22A has a decisive advantage in almost every respect, refer Figure 39.

No less revealing is a comparison against the US Air Force's F-22A Raptor, a fighter designed to excel in air combat, refer Figures 38 and 51. The Joint Strike Fighter is only competitive in networking and core avionics capabilities. This reflects the reality that the F-22A is designed to hunt and kill other fighters, while the Joint Strike Fighter is built to evade them.

> In assessing the suitability of Joint Strike Fighter as a replacement for the F/A-18A in its air combat roles, the Joint Strike Fighter is clearly not a competitive aircraft against regional capabilities such as advanced Sukhoi fighters. The performance compromises inherent in a design built to attack battlefield targets rather than hunt other fighters are apparent and unavoidable. The alternative F-22A Raptor is suitable for this role, with a good margin of capability advantage to cope with future evolution of Russian fighters.

A similar series of comparisons is feasible to assess the suitability of the Joint Strike Fighter as a replacement for Australia's strike capability in the F-111 fleet, refer Figure 40.

For a contemporary strike fighter, these measures can be summarised as:

1. **Speed** - what speeds can the strike fighter sustain for short and extended periods of time. Speed is important since it provides the ability to evade enemy defences, especially fighters, and allows the fighter to spend as little time as possible exposed to enemy attack.

2. **Combat Radius** - combat radius is a measure of what distance the strike fighter can carry its weapons and return to base, without aerial refuelling. It is important in terms of operational economics as it minimises the amount of expensive aerial refuelling needed, and also allows tanker aircraft to maintain a greater distance from opposing defences.

3. **Combat Persistence** - combat persistence is a measure of how long a strike fighter can sustain combat speeds when evading a hostile fighter, and how long it can orbit an area when attacking mobile or fleeting targets, before exhausting its fuel. With the recent shift to persistent strike techniques, persistence is increasingly important to the utility of a strike fighter.

4. **Weapons Capability** - weapons capability is defined by the types and number of guided missiles and bombs a strike fighter can carry. In persistent strike operations, large payloads of weapons are essential.

5. **Radar Footprint** - radar footprint is a measure of what area a strike fighter's radar can surveil. Footprint is important since it is a measure of the fighter's ability to autonomously locate and engage ground and maritime targets.

6. **Passive Sensor Capabilities** - passive sensors allow the fighter to detect opposing air defences, fighters and targets without emitting a radar signal. Such sensors include thermal imagers and passive radar homing and warning receivers.
7. **Stealth** - stealth is a measure of how small the strike fighter's radar and heat signatures are, and determines the distance at which a opponent can detect and engage the fighter. A strike fighter with the radar signature of a golfball will be harder to detect than a fighter with the signature of a beachball.
8. **Core Avionics** - core avionics are the internal suite of computers and supporting hardware and software which manage the strike fighter's systems. The more computing power, and capacity for growth in computing power, the better.
9. **Networking Capabilities** - networking capabilities encompass not only the digital radio modems used for networking, but the supporting software which allows the strike fighter to manage and distribute information gathered by other platforms, and its internal sensors.

If the Joint Strike Fighter is compared to the F-22A Raptor, which has an inherent capability to strike at heavily defended targets, it is demonstrably only competitive in networking and core avionic capabilities, refer Figure 41. This reflects the reality that the Joint Strike Fighter is a much smaller aircraft, built to attack battlefield targets rather than the full spectrum of possible targets.

In a comparison against the proposed Evolved F-111, an F-111 subjected to a range of upgrades, the Joint Strike Fighter has an advantage only in stealth, networking and core avionic capabilities, refer Figure 42. With further upgrades to Evolved F-111 core avionics and networking capability, the only advantage the Joint Strike Fighter has is stealth.

Indeed, so great is the discrepancy between basic strike capabilities between these two aircraft, that two Joint Strike Fighters and at least one aerial refuelling tanker are required to perform the work of a single Evolved F-111.

> As a replacement strike capability for Australia, the Joint Strike Fighter lacks the punch, reach and persistence of the existing F-111, while it lacks the speed and survivability of the F-22A. The strike capability produced by a fleet of 70 to 100 Joint Strike Fighters is inferior in survivability and effect to that produced by a force mix using a smaller number of F-111 and F-22A aircraft.

The compact size of the Joint Strike Fighter precludes the application of significant upgrades to rectify its basic limitations - if Australia buys it it will have to live with its limitations for decades to come. The Joint Strike Fighter is a design carefully optimised to fit a specific role, and its usefulness outside this role is questionable. Even were the Joint Strike Fighter available free of risk at very low unit costs, its inherent limitations resulting from its specialisation make it unsuitable for Australia's diverse needs and challenging regional environment[28].

It is not clear that there is any specific role for which the specialised Joint Strike Fighter is genuinely justified in Australian service.

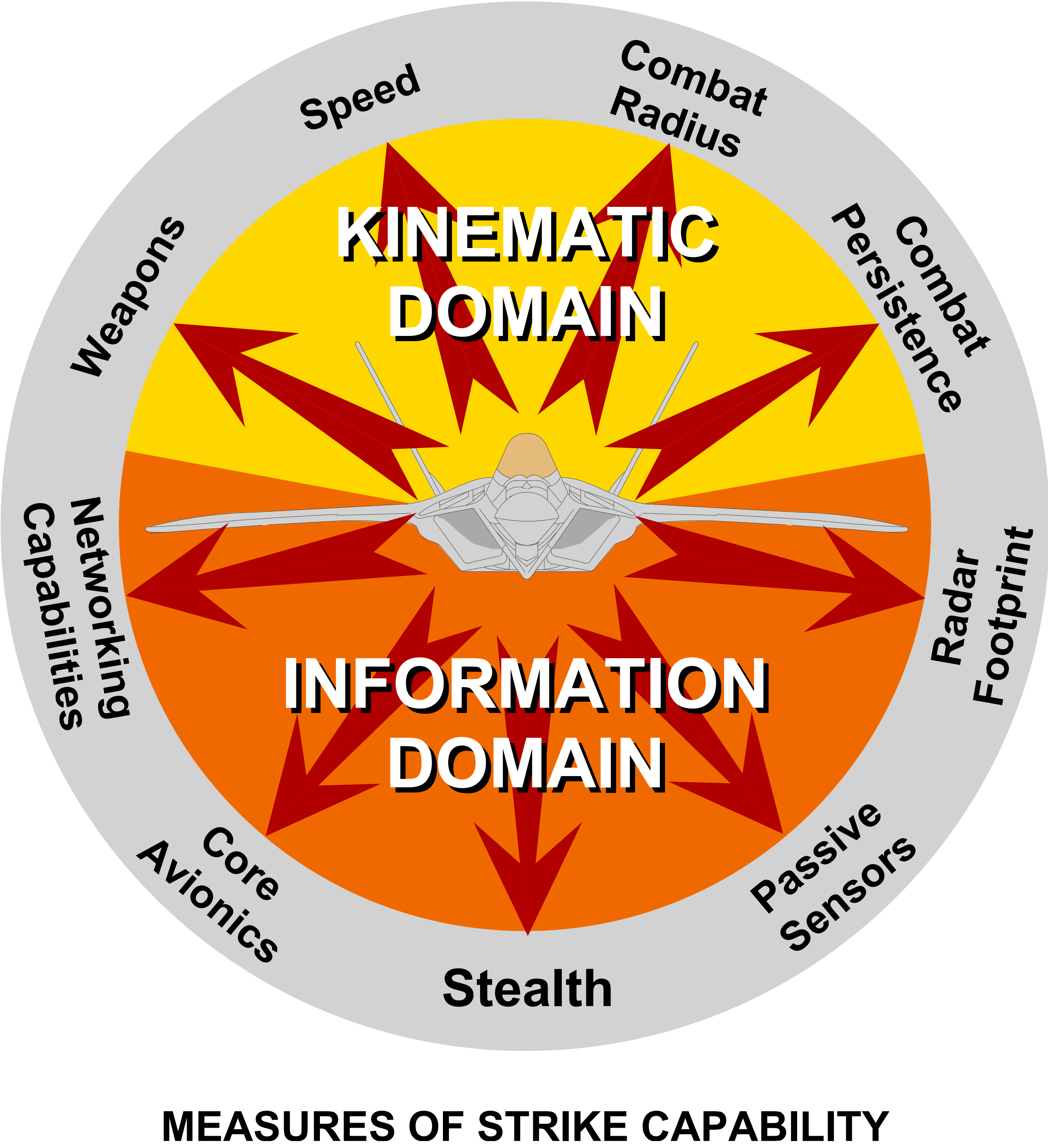

Figure 40: *Decades of experience in modern strike operations allow us to identify nine key measures of strike capability. Four of them fall into the 'kinematic domain' and afford the superior strike greater productivity and more opportunities to evade defences, while five of them fall into the 'information domain', and afford the superior strike aircraft an advantage in situational awareness. Shortfalls in any of these nine areas can be decisive in combat (C. Kopp).*

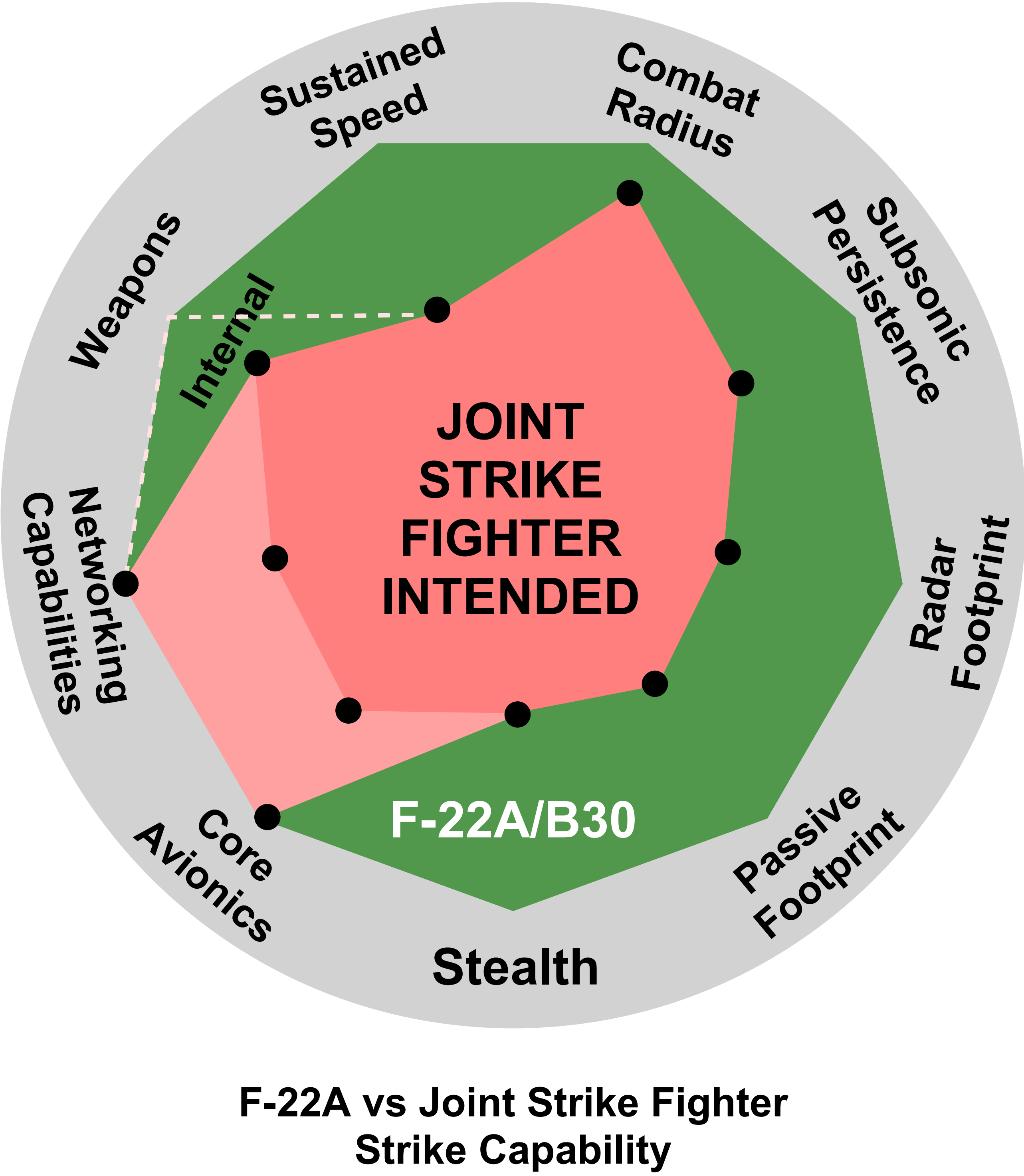

Figure 41: *Comparison of cardinal strike capability measures for the F-22A and the Joint Strike Fighter. While the intended Joint Strike Fighter capability matches the networking and internal computing capabilities of the F-22A, and its internal bomb payload, the Joint Strike Fighter falls short in its capabilities to detect targets and threats, its stealth, and its kinematic performance . In all situations the Joint Strike Fighter is much less survivable than the F-22A, and where external weapons can be carried, delivers only around 3/4 of the payload the F-22A can lift (C. Kopp).*

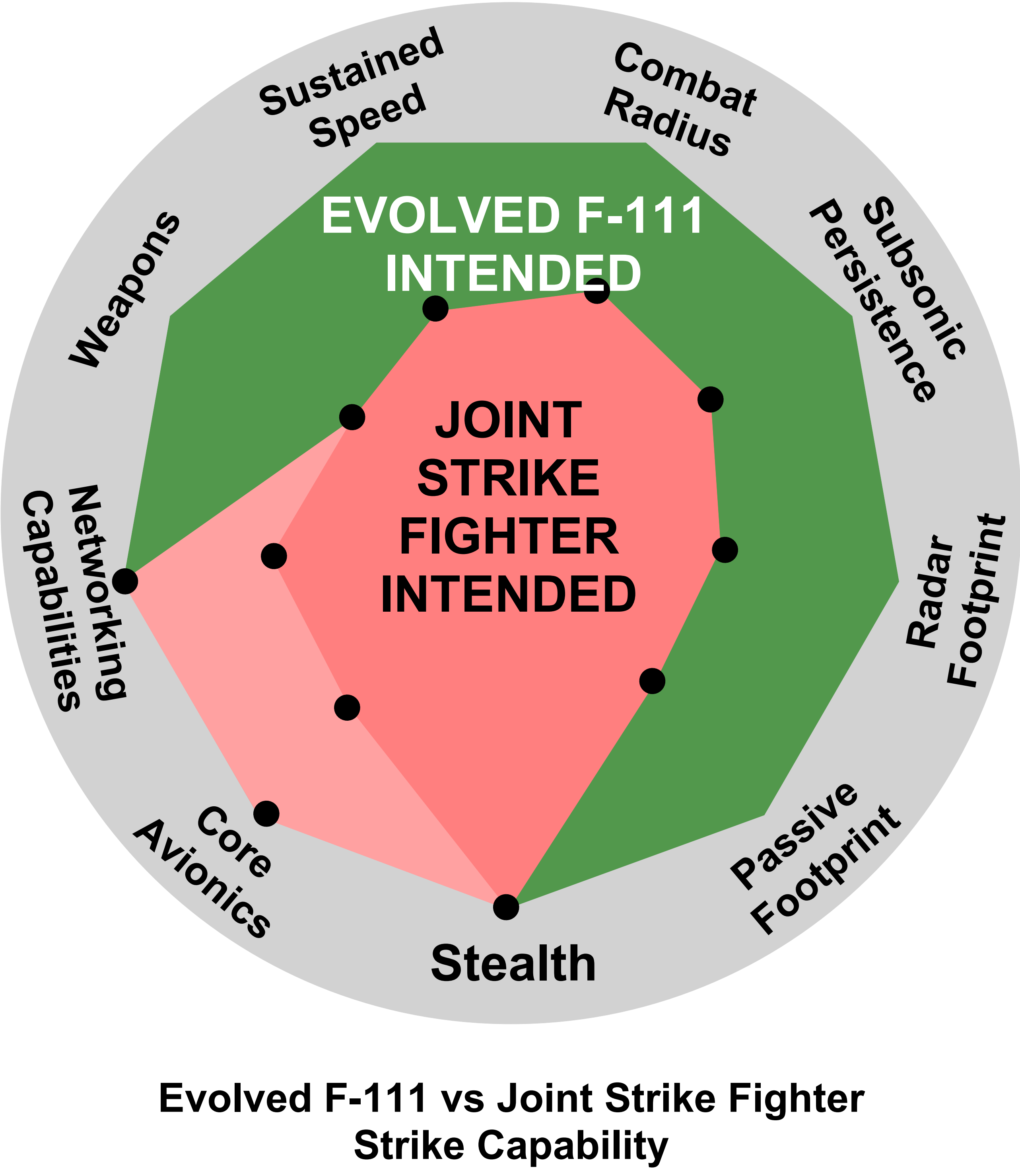

Figure 42: *Comparison of cardinal strike capability measures for the Evolved F-111 proposal and the Joint Strike Fighter. While the intended Joint Strike Fighter capability matches the networking and internal computing capabilities of the Evolved F-111, the Joint Strike Fighter falls short in its capabilities to detect targets and threats, and its kinematic performance . In all situations the Joint Strike Fighter has around one half the bombload of the Evolved F-111, and around one half of its persistence or combat radius. In practical terms, the Evolved F-111 is up to four times as productive as the Joint Strike Fighter (C. Kopp).*

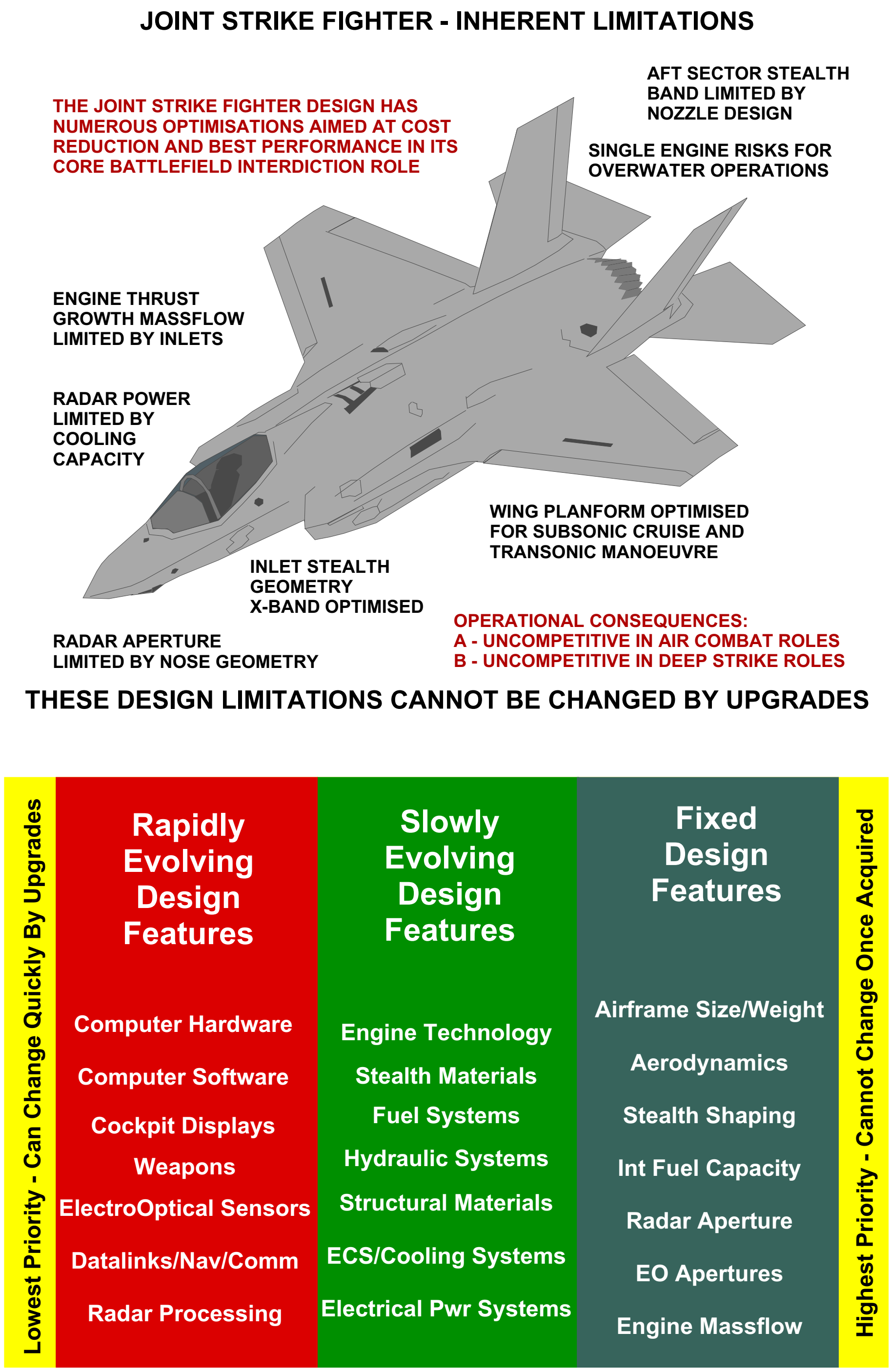

Figure 43: *The Joint Strike Fighter (upper) was designed primarily to support ground forces on the battlefield rather than defeat opposing high performance aircraft or guided missile defences, and is thus not suitable for the developing regional environment. As its limitations are inherent to the design, they cannot be altered by incremental upgrades. It is important to note (lower) that design features in combat aircraft evolve at different rates, and smart choices in buying combat aircraft are those which put priority on those design features which which cannot be changed once the aircraft is built. In this respect the F-22A is a much smarter long term choice than the Joint Strike Fighter (C. Kopp).*

This region does not present the deep and complex land battle environment for which the Joint Strike Fighter is being developed, conversely it presents an environment with greater distances and highly capable air and missile threats to combat aircraft. The case for a specialised battlefield strike fighter is weak, as this is a role which can be easily absorbed by other types such as the F-111, which in many respects performs this role better.

It is also important to note that while the Joint Strike Fighter is a stealthy aircraft, its stealth capability has been compromised, both to reduce its manufacturing costs and make it less politically difficult to export. Unlike the F-22A which is built to be stealthy from most aspects, for a wide range of opposing radar types, the Joint Strike Fighter is built to be stealthy in its forward sector and is optimised to defeat battlefield air defences, rather than strategic air defences, as is the case with the F-22A, B-2A and F-117A. The Joint Strike Fighter will thus not offer, and was never intended to offer, the kind of unchallenged capability demonstrated by the high capability category F-22A and B-2A[29].

From a strategic force structure planning perspective, the notion that a single aircraft type - the Joint Strike Fighter - can replace two very different aircraft types - the F/A-18A and F-111 - without a significant loss in capability, in a challenging and rapidly growing regional environment, is simply not credible.

If Australia wishes to retain the kind of strategic position it held for decades in this region, it will require a combat fleet with at least two different fighter types, one with outstanding air superiority capability, the other with outstanding strike capability. The defacto policy of seeking a single type replacement for the combat fleet is an artifact of an irrelevant past.

The planning constructs which envisage acquiring 70 to 100 Joint Strike Fighters provide a raw strike capability well below that currently possessed in a fleet of 70+ F/A-18A and 35 F-111s, even accounting for factors such as aircraft availability, and guided weapons carriage. Moreover, the small size of the Joint Strike Fighter makes it almost as dependent upon aerial refuelling support as the F/A-18A is, in a strategic planning culture where aerial refuelling tankers are not considered important, and not invested into adequately.

The idea that purchasing more than 100 Joint Strike Fighters can somehow overcome the limitations of the aircraft is not rational. This model significantly increases demand for aircrew, ground personnel, support facilities and aerial refuelling capabilities, all at significant recurring cost over the life of the fleet, during a period where it is unclear that the national demographic can support the additional recurring expenditures and recruiting demands. In strategic terms to achieve any effect, the number of aircraft would have to be of the order of double that currently envisaged.

The US intend to export the Joint Strike Fighter globally, and are expected to provide two configurations, one with full stealth and software capability for US services, and one with reduced stealth and software capability for export. Given the politics of weapons exports, the US will be under significant pressure not to export the US configuration as this will create disagreements in the export customer community. Australia has been identified in a US Air Force research study, published in 2000, as one of three 'trustworthy' allies to whom the F-22A could be exported. However, the politics of Joint Strike Fighter exports will present a major obstacle to Australia gaining full Joint Strike Fighter capability.

Another consideration is that regional nations will see the Joint Strike Fighter for what it is - an low capability category export fighter with limited capabilities, available to most nations with the cash and interest in acquiring it. This will diminish Australia's strategic credibility in a region where a nation's status is often measured by the sophistication and performance of military hardware acquired and operated. In this respect the F-22A presents the opposite, a highly capable and exclusive asset available only to the most trusted US allies.

Ten Strategic Reasons Why the Joint Strike Fighter is Unsuitable for Australia:

1. **The Joint Strike Fighter is not being designed as a high performance air superiority fighter and will not be competitive against advanced Sukhoi fighters in the region.**
2. **The Joint Strike Fighter is not being designed to penetrate heavy air defences thus it will not be competitive against advanced regional missile defences such as the S-300/SA-10 and S-400/SA-20.**
3. **The Joint Strike Fighter has limited stealth performance, optimised to defeat battlefield air defences, compromising survivability in more demanding regional environments and constraining possible tactics.**
4. **The Joint Strike Fighter has limited range and payload performance, making it an operationally uneconomical and uncompetitive strike aircraft for long range and persistent strike operations.**
5. **The small size of the Joint Strike Fighter drives up demands for scarce and expensive supporting aerial refuelling capability in all basic roles.**
6. **With a single engine and the demand for extended overwater operations, a Joint Strike Fighter fleet drives up the demand for supporting combat search and rescue assets.**
7. **Australia will not have an assymetric advantage in supporting capabilities such as Airborne Early Warning and Control, networking and electronic combat in the region.**
8. **With all regional nations of substance operating high capability category fighters such as the Sukhoi Su-27/30 or F-15, Australia will be perceived to have an irrelevant low capability category aircraft in the Joint Strike Fighter.**
9. **With a high risk of late service entry, immaturity, reduced capability and increased unit costs, the Joint Strike Fighter adds significant strategic risks to Australia's strategic position.**
10. **The small size of the Joint Strike Fighter severely limits its long term technological growth potential, in areas other than software, thus limiting its ability to adapt to future regional capabilities.**

4 Conclusions

This submission analysed current planning for the RAAF's future, against funding and risk measures, and developing or deployed regional capabilities for air superiority.

It draws the following series of conclusions:

The planning model devised for the Joint Strike Fighter capability is not viable, both in terms of return on investment in capability, credible delivery timelines, and risk.

The planning model for the interim F/A-18A capability is not viable as the return on investment in capability and additional service life is very poor, while incurring significant risk.

Analysis of acquisition costs and operational economics indicates that a force mix of F-22A and upgraded F-111 fighters is both cheaper and more capable than the proposed plan based on service life extension of the F/A-18A and acquisition of the Joint Strike Fighter.

There are compelling strategic, technological, operational and budgetary reasons why the F-22A Raptor is a better choice than the Joint Strike Fighter as a replacement for Australia's F/A-18A Hornets. These include unchallenged lethality and survivability, affordable return on investment in capability, and very long effective service life.

The industrialisation of Asia, especially China, has resulted in an unprecedented growth of national wealth, and thus in the largest arms buying spree globally, since the last decade of the Cold War. Therefore, in any substantial future regional contingency, Australia will likely have to confront the full spectrum of modern air force capabilities, including high capability category fighters, aerial refuelling tankers, Airborne Early Warning and Control (AEW&C) systems, advanced smart weapons, cruise missiles, missiles designed to destroy AEW&C systems, digital networks, support jamming systems, and should China be involved, strategic bombers.

The United States is confronting serious 'strategic overstretch', and faces budgetary problems which will impact its long term modernisation plans and available force size. Therefore, the United States may have serious difficulty in responding quickly to Australia's needs, with the required force strength. Therefore, Australia needs to plan to perform independent operations in the region, especially when confronting regional air power.

The notion that regional contingencies geographically outside South East Asia would only be dealt with as part of a US led coalition is neither realistic nor supportable.

Dealing with future regional contingencies will require that Australia develop the capability to decisively defeat advanced Russian Sukhoi fighters, strategic bomber aircraft, subsonic and supersonic cruise missiles, and the capability to execute 'counterforce' long range strikes to a distance of at least 2,500 nautical miles, with a credible number of aircraft.

Therefore Australia will have to invest in a high capability category air combat fighter, the F-

22A, retain the high capability category strike capability, currently in the F-111, acquire additional Wedgetail systems, acquire additional aerial refuelling tankers, acquire airborne support jamming systems, acquire much more intelligence, surveillance and reconnaissance capabilities, restore lost support capabilities, and upgrade the aviation fuel replenishment infrastructure of northern airfields.

Should Australia fail to develop these capabilities, it would most likely not achieve air superiority in a regional conflict, with concomitant losses in ADF equipment and personnel, and subsequently, significant material losses to economic infrastructure, especially in the mining and energy industries.

Extensive analysis indicates that the Joint Strike Fighter is not suitable for the kind of operations likely to be encountered in the region, as it is being designed for less demanding roles, especially supporting ground troops on the battlefield.

Australia's best choice both in strategic, budgetary and risk terms is to invest in the F-22A Raptor as its future air combat fighter.

Submission Endnotes

[1] Refer to the Department of Defence Answers to Questions on Notice, Supplementary Budget Estimates Hearing, 2005-06

[2] **Base Year (BY)** - A reference period that determines a fixed price level for comparison in economic escalation calculations and cost estimates. The price level index for the BY is 1.000. US DoD Glossary of Acquisition Acronyms and Terms, 12^{th} Edition – July 2005

[3] US Department of Defence Glossary of Acquisition Acronyms and Terms, 12^{th} Edition – July 2005

[4] Norman R. Augustine – Past President of Martin-Marietta, Former Chairman and CEO of Lockheed Martin and author of "Augustine's Laws", 1983 – Sixth Ed. 1997.

[5] Clarence "Kelly" Johnson – one of the most highly acclaimed and honoured aircraft designers in history and principal driver behind the development of Lockheed Skunk Works and the aircraft that bear this pedigree.

[6] Department of Defence Answers to Question W6, Senator Bishop, on the Joint Strike fighter Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

[7] Letter from the Office of the Minister of Defence in response to an E-letter dated 21 Nov 05 concerning "the meaning of terms related to cost, and the cost of the Joint Strike Fighter".

[8]Including Department of Defence Answers to Question W6 on the JSF Development and Procurement, Pages 20 – 31, Questions on Notice from the Supplementary Budget Estimates Hearing of 02 November 2006.

[9] "The best way to make a silk purse from a sow's ear is to begin with a silk sow. The same is true of money." – Norman Augustine, former President of Martin Marietta and CEO of Lockheed Martin.

[10] "If a sufficient number of management layers are superimposed on top of each other, it can be assured that disaster is not left to chance." and
"Most projects start out slowly - and then sort of taper off." and
"Simply stated, it is sagacious to eschew obfuscation." Norman R. Augustine

[11] The 'product rule' or 'Lusser's product law' is a simple mathematical relationship, discovered during the late 1940s, which is widely used in risk analysis and reliability engineering. Both authors have used it extensively in industry, and one of the authors taught it at university level.

[12] Refer Defence Annual Report 1999-2000; URL - http://www.defence.gov.au/budget/99-00/dar/full.pdf

[13] "In fact, the high cost of keeping the F111 currently is distorting our Air Force's capability to transition to a networked systems based force." - AM Geoff Shepherd, Chief of Air Force, Senate Supplementary Budget Estimates Hearing, 02 November 2005, Hansard Page 87.

[14] RAAF Air Combat Capability Paper for Joint Standing Committee on Foreign Affairs, Defence and Trade, AM Angus Houston dated 03 June 2004, Para 37.

[15] 'A Farewell to Arms Revisited', P A Goon, 26 January 2005, Air Power Australia Web Site URL: http://www.ausairpower.net/FTAR-PAG-180404.pdf.

[16] Specifically, the US 'Bomber Roadmap' or *US Air Force White Paper on Long Range Bombers*, dated March, 1999. In this document the US Air Force maps out long term plans for its fleet of heavy bombers. The B-52H was to remain in service until 2038, the B-1B until a similar date. The significance of this model is that the B-1B uses similar construction techniques, and is similar in performance, to Australia's F-111s. While the current US Quadrennial Defense Review identifies a need for a new long range bomber, to enter service in 2018, historical experience suggests this program may not survive budgetary pressures, or may only result in partial replacement of the existing fleet. The B-1B for instance was to replace the B-52 with around 250 to built, but only 100 were made. The B-2A was to replace the B-52, with 132 to be built, but only 21 were funded.

[17] The naval F-111B was to have been a dedicated interceptor for fleet defence against long range bombers armed with cruise missiles. This variant was cancelled, but shared nearly all of its airframe design in common with Air Force variants - in part the reason why the F-111 airframe has such longevity. Provision of this capability requires a new radar and software to support suitable missiles such as the AIM-120 and AIM-132.

[18] Application of this technique two years ago identified significant economies in fuel burn if legacy B-52 aircraft were to be re-engined, as the reduced demand for aerial refuelling support rapidly offset the cost of the new engines. During the early 1990s, following the 1991 Gulf War, this technique showed the compelling cost advantages enjoyed by the F-117A stealth fighter and F-111 in combat operations, compared to the Tier 2 F-16 fighter. F-117A required few supporting assets due to its stealth, saving money, the F-111 required less aerial refuelling support, also saving money.

[19] For all intents and purposes this is the same internal payload typically envisaged for the planned Joint Strike Fighter, which is a purpose designed bomber.

[20] The high power rating of the F-22's APG-77 radar makes it the most difficult US fighter radar to jam by opposing defences, and the radar's power also allows it to surveil or map ground targets from greater ranges than any other fighter radar.

[21] This comparison applies also to the Joint Strike Fighter, which is being designed around the limited performance and speed capabilities of legacy fighters, specifically the F-16 and F/A-18.

[22]The Soviet buildup commenced during the late 1970s, as a range of new military technologies were introduced. In part these included systems patterned after US designs introduced during the 1970s, and in part systems based on US technology acquired from Vietnam and Iran. Of significance is that the Soviets deployed hundreds of new generation Su-27 and MiG-29 fighters, S-300 Surface to Air Missile systems, new radar systems like the 64N6 series, and a wide range of land and naval warfare systems.

[23]During the 1980s and 1990s Australia operated the F/A-18A and F-111C, while no regional nation operated comparable capabilities until the introduction of limited numbers of the MiG-29,

comparable to the F/A-18A. During the mid to late 1990s hundreds of Su-27 and Su-30 Flanker fighters were ordered across the region, with orders ongoing since.

[24] Hale provides an exhaustive survey and analysis in 'China's Growing Appetites', The National Interest, also see Kenny in 'China and the Competition for Oil and Gas in Asia', Asia-Pacific Review.

[25] While modern anti-ship missile defence systems can be highly effective against small numbers of subsonic or supersonic anti-ship cruise missiles, they are all limited in how many inbound missiles they can engage and destroy concurrently. Accordingly, the Soviets developed a tactic during the Cold War based on saturating a warship's defences with more cruise missiles than the system could defend against. This tactic has been actively exported in Asia and is detailed in contemporary Russian marketing materials.

[26] Contemporary literature often uses the terms 'air dominance' or 'air supremacy' rather than 'air superiority'. The condition of air dominance or air supremacy is one where an opponent will not even attempt to contest for control of the air, or no longer has the capability to do so. In a condition of air superiority, an opponent may contest control of the air, but cannot achieve it. Some definitions of air superiority identify it as limited in time and geographical extent, ie air superiority exists only when the more capable force is present, and not otherwise. For instance, following this definition the UK achieved air superiority in the Falklands conflict, but only in those areas patrolled by Royal navy fighters. The practical consequence was that in areas not patrolled by fighters, the British fleet suffered significant losses to Argentinian air attack.

[27] High resolution radar mapping techniques using Synthetic Aperture Radar (SAR) technology can now produce ground maps with feature sizes of centimetres, whilst penetrating cloud, rain, haze and sandstorms, providing the capability to detect, identify, track and engage even small ground force units. Ground and Maritime Moving Target Indicator (GMTI, MMTI) capabilities are designed to detect slow moving surface targets, through weather, and thus provide the capability to detect, track and engage, and often identify, ground vehicles and even small boats. The expectation is that such radars will become the defacto standard in most combat aircraft over the coming decade. Advanced production variants of the Su-27 and Su-30 are being provided with or already have SAR, GMTI and MMTI capabilities.

[28] It is important to observe that this problem arises with all low capability category fighters, examples including the F-16C, F/A-18E/F, Eurofighter Typhoon, Dassault Rafale and SAAB Gripen. All of these have been canvassed or proposed at various times as replacements for the F/A-18A and all are now wholly non-viable choices.

[29] A major survivability issue now arising is the emergence of multiple seeker types in Russian long range air to air missiles. While radar stealth capability can defeat radar guided missiles, it is ineffective against heatseeking and passive anti-radar missiles. Russia is now exporting the semi-active radar homing R-27R/ER/ER 1 Alamo A/C, the heatseeking R-27T/ET/ET1 Alamo B/D, the anti-radiation R-27P/PE Alamo E/F, and the active radar guided R-77 Adder. The heatseeking R-77TE and anti-radiation R-77PE Adder variants have been reported. A fighter with limited stealth is exposed to long range shots using these weapons, and neither the heatseeking nor the anti-radiation seekers are easily defeated.

5 Annex A - F-22A Data

Figure 44: *The F-22A is uniquely the only fighter in production, or planned, which combines supersonic cruise capability and top tier stealth performance. (US Air Force).*

This Annex provides a series of charts and diagrams which illustrate basic F-22A capabilities and provides some comparisons against the Joint Strike Fighter.

Figure 45: *An early production F-22A Raptor releasing a GBU-32 JDAM satellite aided guided bomb (upper). The F-22A is a true multirole fighter, intended to excel in the air superiority role, but also to attack the most heavily defended surface targets with precision guided munitions. With unchallenged survivability it will also be used for electronic and imaging radar reconnaissance. The F-22A is designed to carry internal weapons where stealth is required, but can also carry significant external payloads where stealth is not required (lower) (US Air Force).*

Top ten reasons why the F-22A Raptor is the best choice to replace Australia's F/A-18A Hornets:

1. **GREATER CAPABILITY BETTER SUITED TO AUSTRALIA'S NEEDS.** The F-22A is over twice as capable compared to what is being planned as the Joint Strike Fighter.
2. **MORE COST EFFECTIVE.** Buying the F-22A and upgrading the F-111s will be a cheaper yet more capable solution to the current plans.
3. **BETTER DEFINED AND EARLIER SCHEDULE (NO RISK OF CAPABILITY GAP).** Buying the F-22 toward the end of the currently planned full rate production would put the buy in the 2010-2012 timeframe.
4. **LESS TECHNICAL AND FINANCIAL RISK.** The F-22A is a known commodity that is flying today. The Joint Strike Fighter has yet to fly let alone complete development and demonstrate its capability.
5. **MAINTAINING STRATEGIC POSITION AND RELEVANCE IN THE REGION.** The survivability of the Joint Strike Fighter against post 2010 Sukhoi Su-30 derivative aircraft is highly problematic.
6. **DEVELOPING AUSTRALIAN DEFENCE INDUSTRY.** By targeting return on investment already made in F-111 support capabilities.
7. **LESS EFFECT ON BALANCE OF TRADE.** Fewer tax payer dollars have to be spent off shore.
8. **BETTER LIFE CYCLE GROWTH CAPABILITY.** The F-22A and F-111 are larger aircraft with greater system growth potential.
9. **BETTER LONGEVITY AND RETURN ON INVESTMENT.** The F-22A and F-111 are more robust airframe designs that have not been subject to the 'Cost As an Independent Variable' (CAIV) driven cost and capability reductions as is the case with the Joint Strike Fighter.
10. **INDEPENDENCE, SELF RELIANCE AND VALUED CONTRIBUTION TO DEFENCE OF THE REGION.**

With the F-22A in service as a replacement for the F/A-18A, it provides the capability to defeat the most capable regional systems, creating a more permissive operational environment for the F-111.

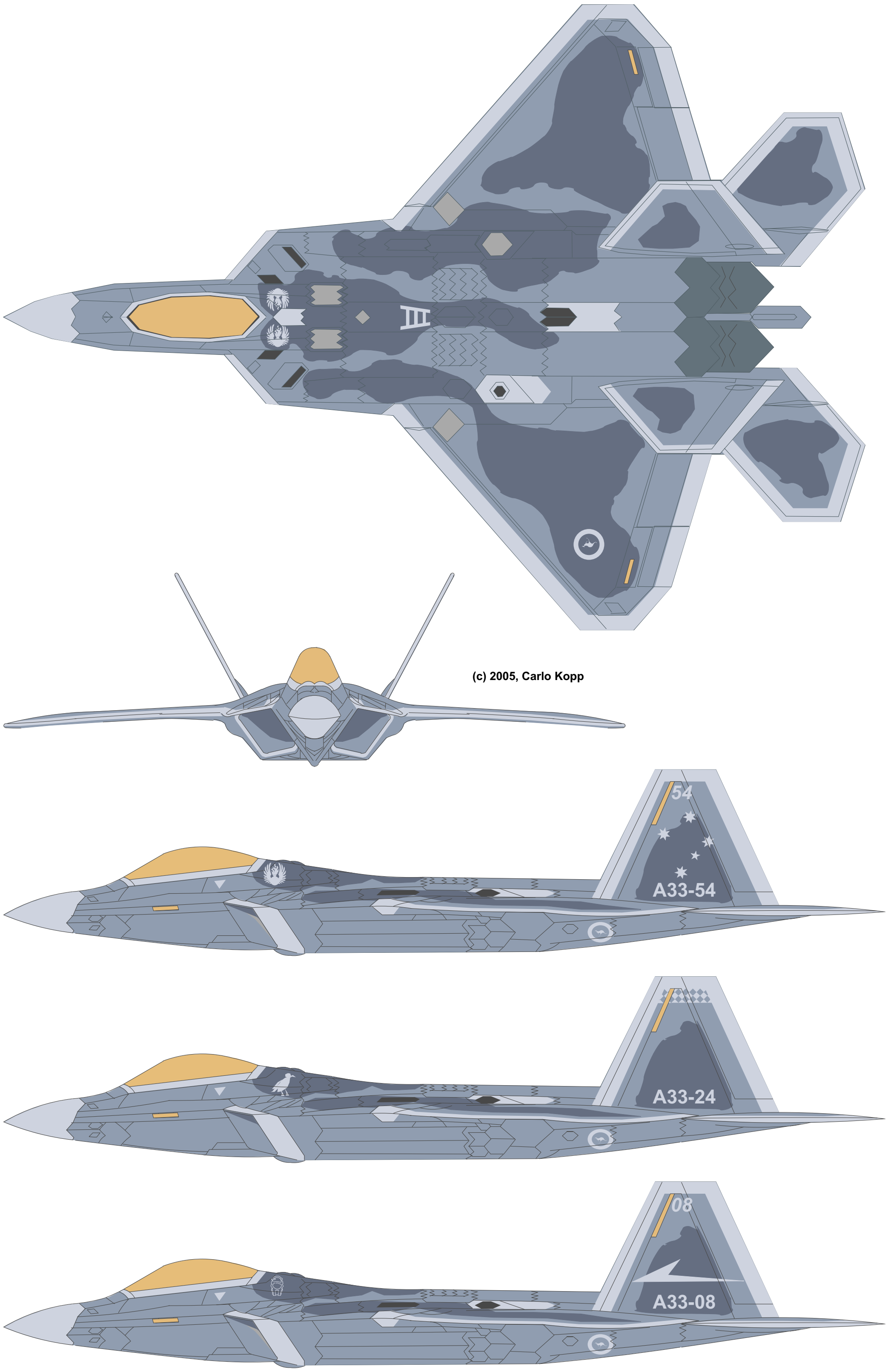

Figure 46: *This diagram illustrates the F-22A in RAAF colours (C. Kopp).*

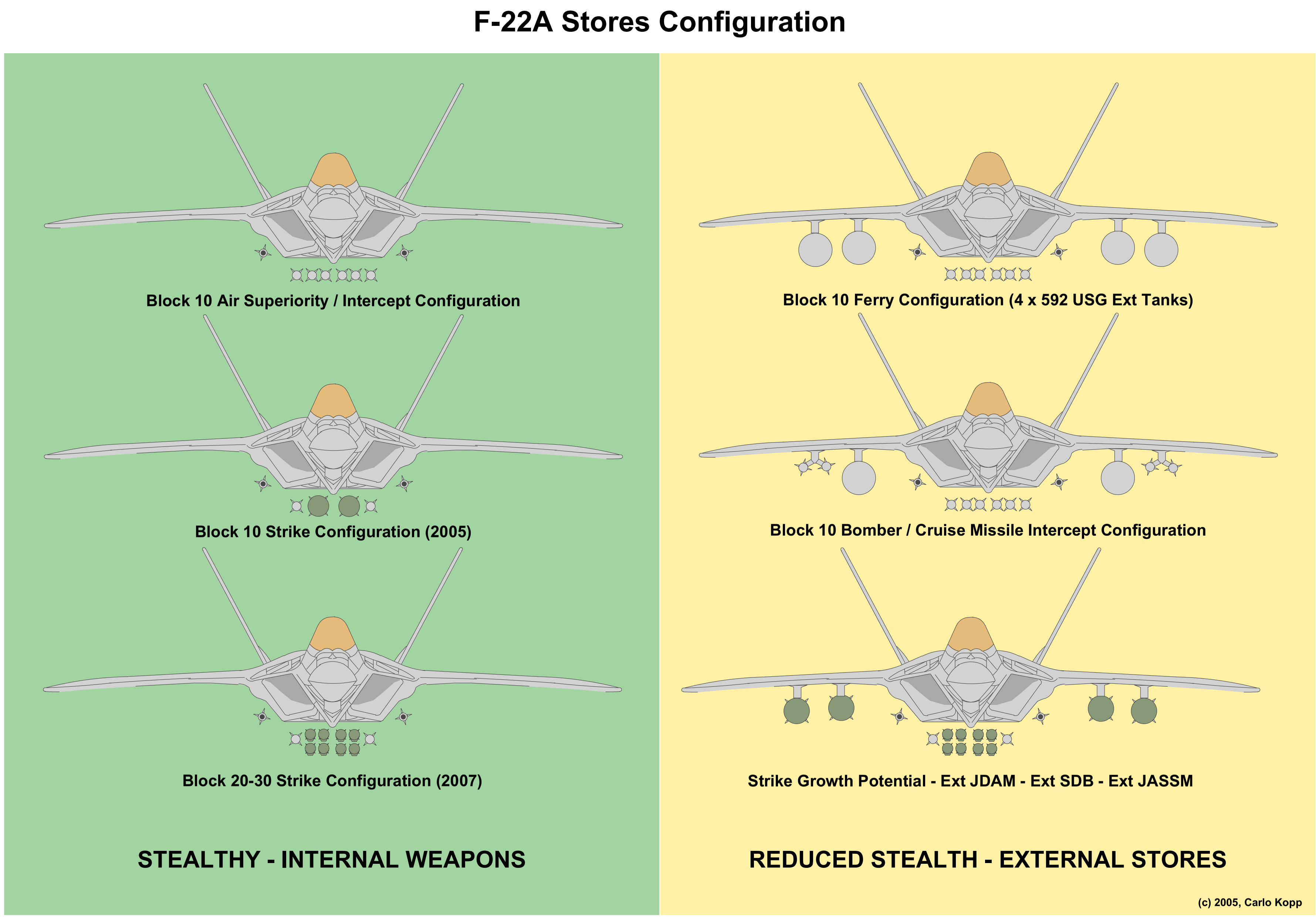

Figure 47: *The F-22A exceeds the internal Air-Air Missile carriage capability of the Joint Strike Fighter, and matches the stealthy internal weapons carriage capability using the Small Diameter Bomb, and GBU-32 satellite aided bomb. The F-22A exceeds the non-stealthy external weapons and fuel carriage capability of the Joint Strike Fighter by 50%. Used as a bomber, the F-22A can carry as as many or more weapons than the Joint Strike Fighter, and do so in situations where the Joint Strike Fighter could not survive (C. Kopp).*

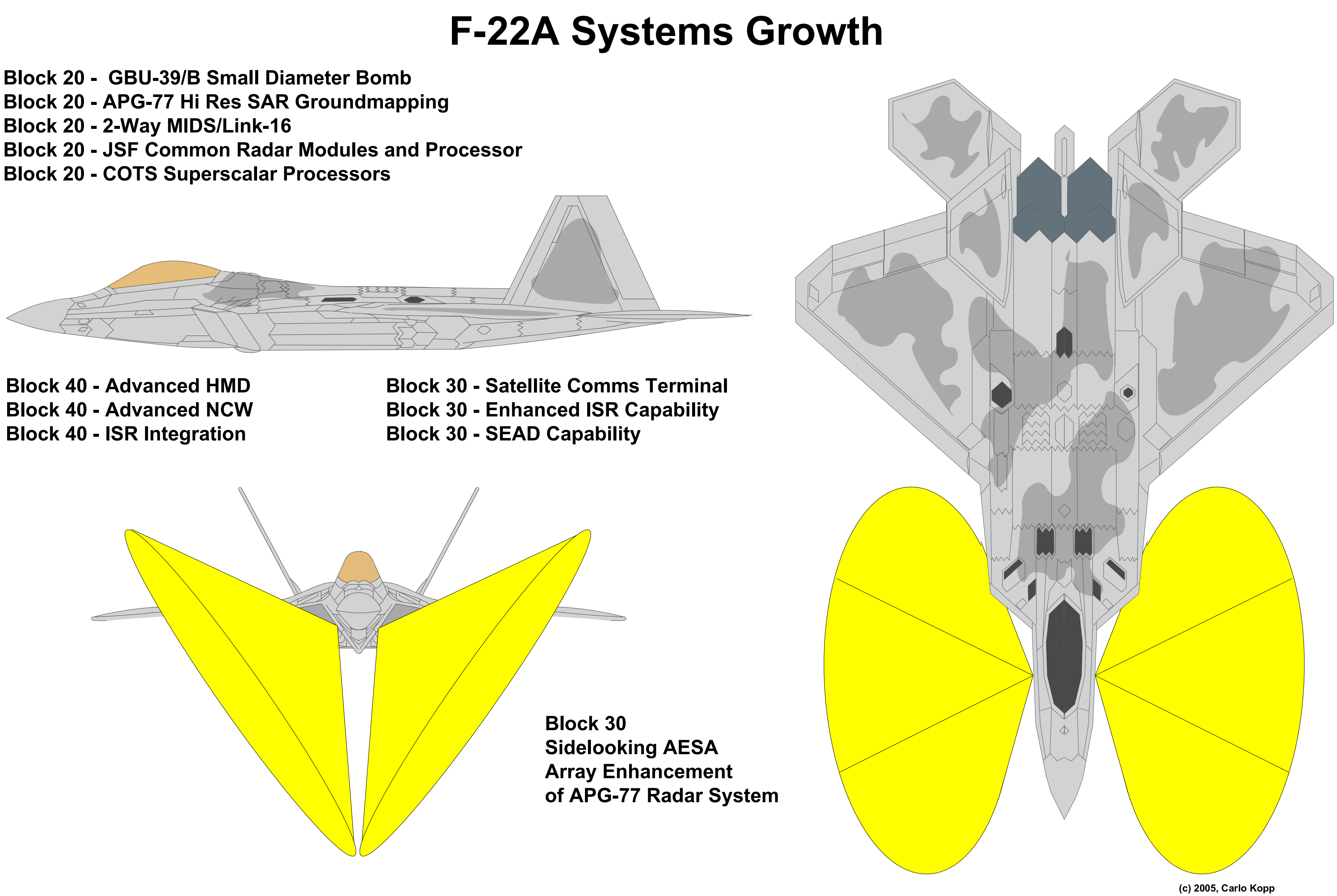

Figure 48: *The production F-22A will undergo a series of block upgrade enhancements over coming years. The strike and Intelligence Surveillance Reconnaissance capabilities it provides will match or exceed those of the Joint Strike Fighter, while the F-22A will always be more survivable in combat than the smaller Joint Strike Fighter (C. Kopp).*

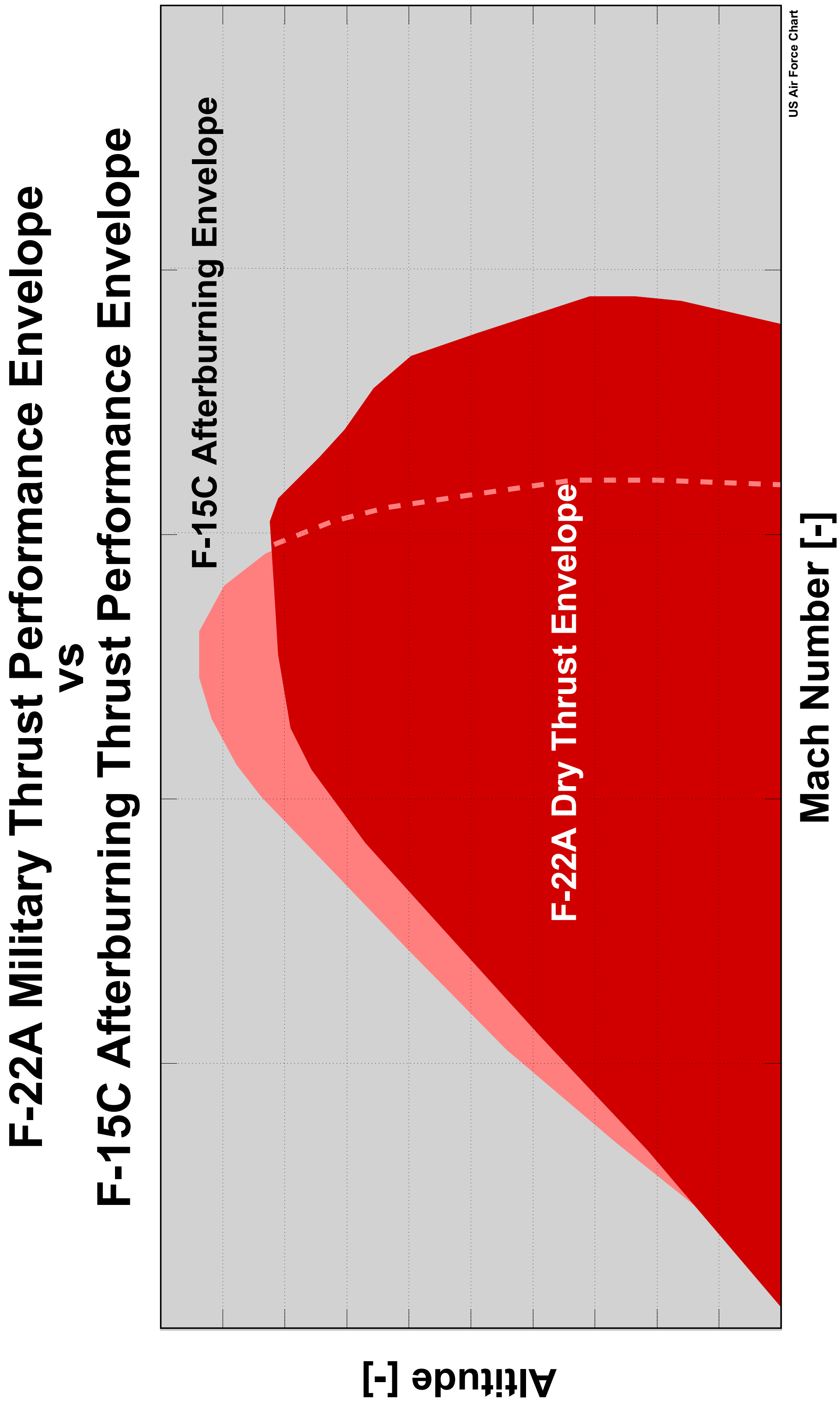

Figure 49: *The F-22A will provide unprecedented gains in energy performance and supersonic persistence over established fighters, and the Joint Strike Fighter. This chart compares the performance envelope of the F-15C at maximum attainable engine performance using afterburner, against the performance envelope of the F-22A without the use of afterburner. Afterburner use increases fuel burn severalfold (US Air Force).*

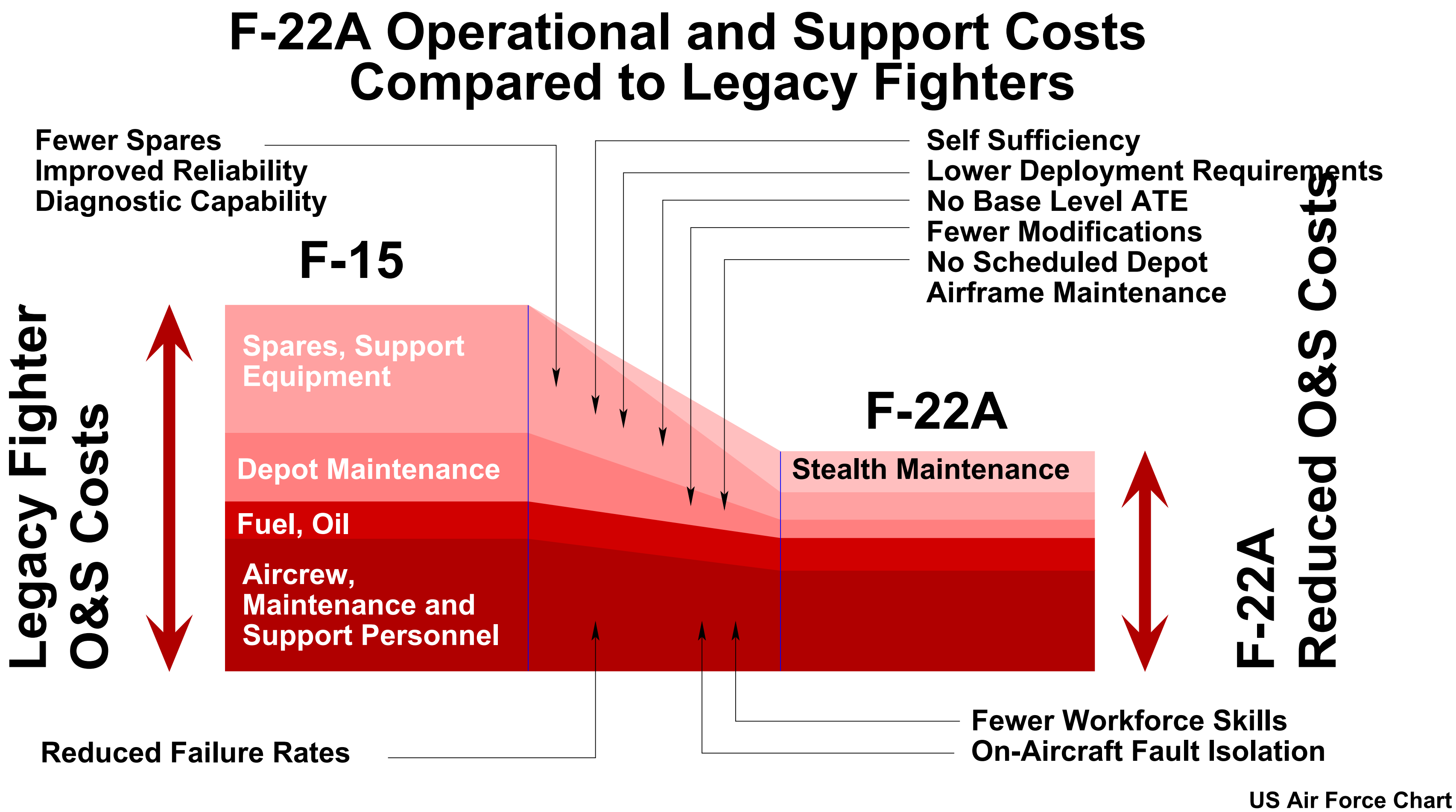

Figure 50: *The F-22A will be much cheaper to operate compared to established fighters. This chart shows a comparison against the F-15, which incurs similar operational and support costs to the RAAF's F/A-18A. The introduction of deeper depot level maintenance activities and planned upgrade programmes (HUG 2 & 3 plus Minor Item Submissions) will see the F/A-18A O&S Costs balloon above those for the F-15 by some degree. (US Air Force).*

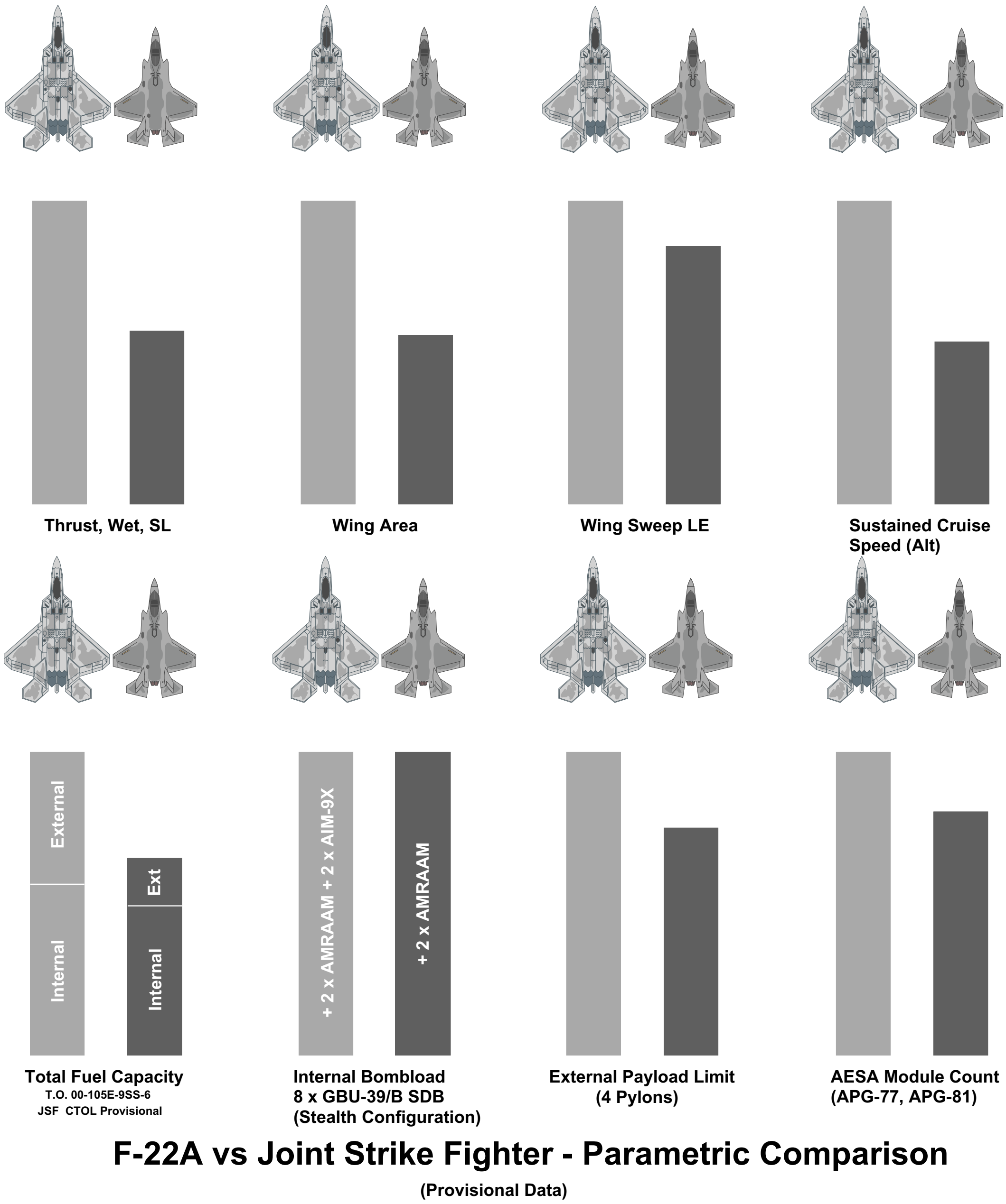

Figure 51: *The F-22A outperforms the Joint Strike Fighter in all cardinal specifications (C. Kopp).*

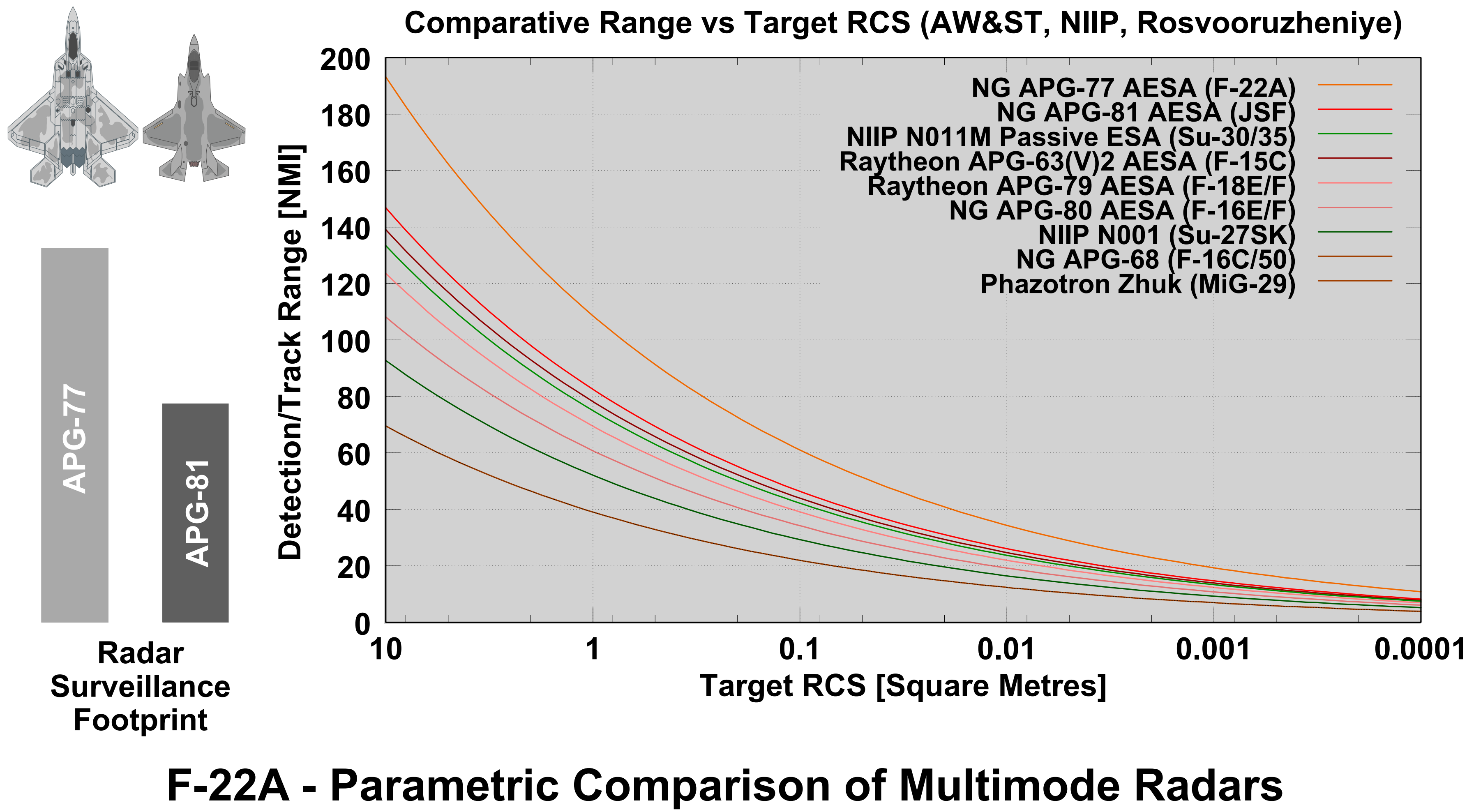

Figure 52: *The F-22A is equipped with the most powerful active array radar ever installed in a fighter aircraft. This will provide it with unprecedented range performance, but also opens up the option of using it as a microwave directed energy weapon to disrupt opposing electronic systems. US sources indicate it will also be used to jam opposing X-band radars (C. Kopp).*

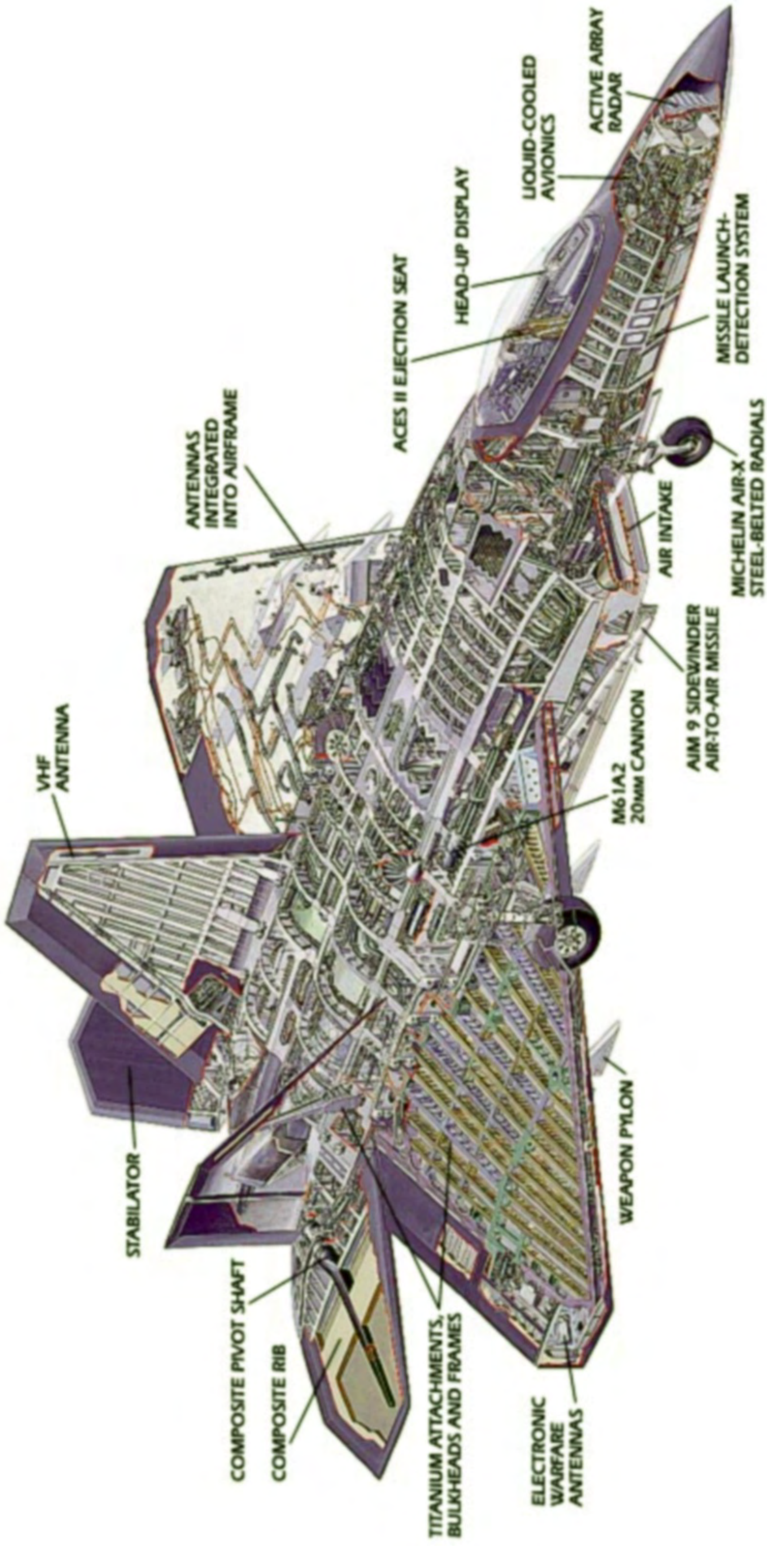

Figure 53: *F-22A cutaway chart (GlobalSecurity.org).*

6 Annex B - Comparison of Current NACC Plan vs 2001 Industry Proposal

This annex contains a detailed tabular breakdown of the comparative scoring performed between the current Defence NACC plan and the 2001 industry proposal. For convenience, the summary table in Table 2 is replicated here.

Proposal Metric	Australian Industry Solution (2001) Score	Current Defence Plan Score
Combat Capability Subtotal	+2	-10
Supersonic Cruise	0	-2
All Aspect Stealth	-1	-1
Phased Array Radar	0	-1
Internal Weapons 2 klb	0	-2
Max External Payload	+1	0
Int Weapons Payload	+1	-1
Combat Radius (Int Fuel)	0	-2
Cost Metrics Subtotal	+2	-6
Acquisition Cost	+1	-2
Acquisition Model	+1	-2
Life Cycle Costs	+1	-1
Return on Investment	0	-1
Risk Metrics Subtotal	+3	-13
Acquisition Risk	0	-2
Cost Risk	0	-2
Design Risk	0	-1
Strategic Risk	0	-1
Strike Capability Gap	+1	-2
Air Sup Capability Gap	+1	-2
Air Def Capability Gap	+1	-2
Net Assessment	+7	-29

Table 5: Summary table of assessment scoring for current defence NACC and interim planning against the 2001 Australian Industry solution.

Note on Analysis Method:

The analysis technique and scoring method used is based upon *ordinal comparison* which is a technique where parameters are ranked by relative magnitude. The scoring is thus based on comparing a large number of parameters against a target, and ranking each score as superior / equal / inferior. This method was chosen over *cardinal comparison*, in which the relative magnitudes of parameters are each expressed as a number, such as a percentage. For many of the metrics in this annex, this ordinal method in fact favours the Joint Strike Fighter and the F/A-18A HUG, by concealing the scale of advantage enjoyed by the F-22A and F-111 in comparison. This analysis is therefore unusually conservative.

COMPARISON : CURRENT PLANS OF DEPARTMENT OF DEFENCE (NACC) VS AUSTRALIAN INDUSTRY PROPOSAL (2001)

Score	*Australian Industry Solution (Proposed 2001)*	**Capability, Cost, & Project Risk Metrics**	*Current Defence Plans*	Score
+1 0 -1 [1]	*2008 Onwards* [2]		*2010 to 2018*	+1 0 -1
			2018 Onwards	
Brief Description of Two New Air Combat Capability (NACC) Models for Australia				
	55 x F/A-22A : 50 full systems, start IOC by 2010 + 5 attrition aircraft by 2015 AND 36 x F-111s, progressively evolved by Australian Industry to Evolved F-111S configuration THROUGH incorporation of Incremental Block Upgrades PLUS additional aircraft and parts from the AMARC [3] at less than 10% of book value. Initial LOT = 2025+ (could be extended) This model meets needs for: - Defence Capability – Manpower challenges – Economy/Balance of Payments – Industrial Base Development – Minimising Dependency Risks – Leaving a 'Better Australia'	Air Combat Force Structure Model	Up to 71 x F/A-18A HUG aircraft assuming planned phases of Hornet Upgrade Program (HUG) have been completed PLUS Fuselage Centre Barrel Replacement (CBR) PLUS multiple Minor Item Submission (MIS) upgrades PLUS Air 5418 (FOSOW) PLUS Air 5409 (Bomb Improvement Program) PLUS Tanker Aircraft to provide range coverage PLUS cruise missile capability on AP-3C	
			Between 75 to 100 x JSF Systems : Low Rate Initial Production aircraft (Block 1, Block 2 and Block 3) PLUS ongoing upgrades to incorporate war fighting capabilities. Significant Single Type dependency risks. Combat UAV option in Tranche 3, though wildly speculative at this stage. [4]	

Score	Australian Industry Solution (Proposed 2001)	Capability, Cost, & Project Risk Metrics	Current Defence Plans	Score
+1 0 -1 [1]	2008 Onwards [2]		2010 to 2018 / 2018 Onwards	+1 0 -1
2	Sub Total	Combat Capability Metrics	Sub Total	-10
0	F/A-22A : Standard	Supersonic Cruise Capability	F/A-18A HUG : None and never will have.	-1
0	Evolved F-111S : Achieved via engine upgrade (F110 ex F-14D or F119)		JSF : None and never will have.	-1
0	F/A-22A : Standard	All Aspect Wideband Stealth Capability	F/A-18A HUG : None	-1
0	Evolved F-111S : Not required. Primarily stand-off missile carrier and cruise missile interceptor. Air dominance fighter and strike capabilities provided by F/A-22A		JSF : None Optimised for 'Forward' and 'Side' aspect Best performance limited to X-Band, only. Target KPP downgraded to LO from VLO – an order of magnitude change.	-1
0	F/A-22A : AN/APG-77 [5]	Phased Array Radar Capability	F/A-18A HUG : None	-1
0	Evolved F-111S : AN/APG-80 or AN/APG-81[5] via upgrade. Could be done with funded NRE in support of mitigating risks on JSF Program		JSF : AN/APG-81 [5]	0
0	F/A-22A : Not required, due F-111	Internal Carriage 900 kg Weapons	F/A-18A HUG : None	-1
0	All F-111 (but R/F-111) : Standard		JSF : None (CV variant only)	-1

Score	AUSTRALIAN INDUSTRY SOLUTION (PROPOSED 2001)	CAPABILITY, COST, & PROJECT RISK METRICS	CURRENT DEFENCE PLANS	Score
+1 0 -1 [1]	*2008 Onwards* [2]		*2010 TO 2018*	+1 0 -1
			2018 Onwards	
0	F/A-22A : 9,000 kg	Maximum External Payload (Any Weapon Type)	F/A-18A HUG : 6,800 kg Typical for generic small tactical fighter	0
+1	Standard F-111 : 13,600 kg		JSF : 6,800 kg Typical for generic small tactical fighter	0
0	F/A-22A : 2 x 450 kg or 8 x 175 kg	Internal Weapons Payload (Smart Bombs)	F/A-18A HUG : None Does not have a weapons bay.	-1
+1	F-111 : 2 x 900 kg Evolved F-111S: 8 x 175 kg		JSF : 2 x 450 kg or 8 x 175 kg	0
0	F/A-22A : 700+ NMI - <u>PLUS</u> long range asymmetric sub sonic cruise for strike, ISR and electronic attack roles as well as ferry - > 1,000 NMI	Combat Radius on Internal Fuel Suited to Australian Island Continent Status	F/A-18A HUG : 450 NMI (Requires external fuel tanks to achieve this range with any effectiveness)	-1
0	Standard F-111 : 1,000+ NMI Evolved F-111S : >1,300 NMI Asymmetric, long range cruise capability for strike, ISR, cruise missile intercept, and electronic attack roles as well as ferry.		JSF : 650 NMI <u>Note</u>: Combat radius yet to be demonstrated in clean configuration and carrying external stores. Expect this will occur some time after 2006, most likely in 2008 test program.	-1

Score	Australian Industry Solution (Proposed 2001)	Capability, Cost, & Project Risk Metrics	Current Defence Plans	Score
+1 0 -1 [1]	2008 Onwards [2]		2010 to 2018 2018 Onwards	+1 0 -1
2	Sub Total	Cost Metrics	Sub Total	**-6**
+1	F/A-22A: (in 'then year' dollars) 50+5 Systems $US6,800.0 m (Subject to negotiation on model - potential for significant reduction) <u>Estimate in Australian Dollars</u> @ 2010 exchange $A9,855.3 m	Value for Money/Cost Effective Acquisition Cost	F/A-18A HUG : $A3,000+ m <u>PLUS</u> Minor Item Submission (MIS) Project costs, Estimate (MIS) $A100m to $A200m These figures are what Defence calls 'cash dollars' which would appear to be 'then year' dollars.	-1
0	Evolved F-111S: (in 2004 dollars) Upgrades $A1,760.5 m 10 x Attrition Acft $A 133.3 m (<u>PLUS</u> spares eg. wings, etc.) <u>Total</u> : $A1,893.8 m		JSF : $A15,000 m+ NACC Budget - (Assumed 'then year' dollars) Often Stated $US45m per aircraft is Avg Unit Recurring Flyaway <u>Cost</u> in 2002 dollars not <u>Price</u> in 2012+	-1
+1	F/A-22A : FMS purchase or Lease/Buy or combination of both, with strategic offsets available. <u>Negotiation Win Themes</u>: - Strategic Importance to US - Support for USAF buy/need	Value for Money /Cost Effective Acquisition Model	F/A-18A HUG : large block upgrades and multiple Minor Item Submission (MIS) Projects.	-1
0	F-111 : incremental upgrades to existing fleet, acquire attrition reserve from AMARC at less than 10% of book value, as has been achieved previously.		JSF : Tier 3 partner purchase <u>PLUS</u> large Loss/Lead and high government overhead Industry Involvement Program with no guarantees.	-1

Score +1 0 -1[1]	AUSTRALIAN INDUSTRY SOLUTION (PROPOSED 2001) — *2008 Onwards*[2]	CAPABILITY, COST, & PROJECT RISK METRICS	CURRENT DEFENCE PLANS — *2010 TO 2018* / *2018 Onwards*	Score +1 0 -1
0	**F/A-22A : Integrated avionics, 4^{th} generation engine.** **Requirement for life cycle costs to be less than 60% those of F-15.** **Demonstrated in Initial Operational Test and Evaluation to be on target.** **Australia being more than 20% of world fleet provides great opportunity, combined with using attrition aircraft, for Australian Industry involvement in life cycle upgrades. Also, stronger buying and negotiation position.**	**Value for Money/Cost Effective Life Cycle Costs** (Note: Present Value Analysis methods used to provide valid basis for comparison. Same escalation and discount factors used for both models, where applicable.)	**F/A-18A HUG: Legacy federated avionics; aircraft undergoing deeper maintenance for the first time in conjunction with large suite of modification and refurbishment projects to be done in parallel. Figures derived from analysis of Defence Annual Reports 1999 to 04, Defence Capability Plan to 2015, and previous [6]. PRESENT VALUE $'s in 2004 :** **F/A-18A HUG et al** **Capital Costs (DCP, MIS) >$A2,241.7 m** **F/A-18A HUG (to 2015 [7])** **Total Operating Costs >$A3,002.7 m** **Total : >$A5,244.4 m** **Note : Costs to 2015[4] vs 2020 for F-111S**	-1
+1	**F-111 : Mostly integrated avionics, 4^{th} generation engine via upgrades. Figures derived from RAAF Air Combat Capability Paper to Parliament. [8] PRESENT VALUE $'s in 2004 :** **F-111 to 2020 (RAAF)** ***Total Cost of Ownership*$A2,224.5 m** **Evolved F-111S (Industry)** ***Total Cost of Upgrades* $A1,090.5 m** **Total : $A3,315.0 m**		**JSF: Integrated avionics, 4^{th} generation engine, CAIV and international partnering.** **To be demonstrated in Initial Operational Test and Evaluation presently projected to occur circa 2012.** **Presumed will meet and achieve metric.**	0

Score	Australian Industry Solution (Proposed 2001)	Capability, Cost, & Project Risk Metrics	Current Defence Plans	Score
+1 0 -1 [1]	2008 Onwards [2]		2010 to 2018 / 2018 Onwards	+1 0 -1
0	F/A-22A : Expected life of 40+ years	Minimum of 10 Year Return on Investment Period After Acquisition/Upgrade	F/A-18A HUG : Planned to be completed sometime after 2010. Further upgrades/rebuilds would be required to go beyond 2015.	-1
0	F-111 : 2005-2025+ (Could be extended, or replaced with FB-22 or later build JSF or other capability).		JSF : Expected life of 30+ years subject to approval for full rate production sometime after 2012.	0
3	Sub Total	Risk Metrics	Sub Total	-13
0	F/A-22A : LOW	Low Acquisition Risks	F/A-18A HUG : LOW in Avionics; HIGH in Centre Barrel Replacement (CBR); overall HIGH in schedule since multiple element project with close interdependencies which, in turn, is part of a 5 project CAPSTONE Program which has yet to be managed as a CAPSTONE. HIGH risk exposure on aircraft availability.	-1
0	Evolved F-111S : LOW Due to extensive research, knowledge and experience on aircraft now resident in Industry, DSTO and, to lesser extent, the RAAF (latter due to downsizing and deskilling).		JSF : HIGH Potential for significant variations in capability, cost and schedule timelines with high likelihood of current risks materialising and further risks arising eg. software problems, partners leaving program, Congressional intercession	-1

Score +1 0 -1 [1]	Australian Industry Solution (Proposed 2001) 2008 Onwards [2]	Capability, Cost, & Project Risk Metrics	Current Defence Plans 2010 to 2018 / 2018 Onwards	Score +1 0 -1
0	F/A-22A : LOW Since mature, inproduction design with buy at end of current production (low cost end when NRE recovery and recurring engineering (RE) costs are at lowest levels). Increase of USAF buy to 300+ units	Low Cost Risks	F/A-18A HUG : HIGH High probability of additional structural refurbishing costs, more extensive rectifications arising from first time deeper maintenance, and avionics/weapons upgrades as further delays development challenges arise in JSF program	-1
0	F-111 : LOW		JSF : Very HIGH – uncertainties in total numbers will persist until at least 2015	-1
0	F/A-22A : Nil	Low Design Risk	F/A-18A HUG : MEDIUM LOW	0
0	F-111 : LOW Incremental upgrades of legacy avionics (cockpit, radar) and legacy systems (Pave Tack) <u>PLUS</u> an engine upgrade in the 2010 to 2020 time window.		JSF : HIGH Remains in development with difficulties in performance, weight and cooling capacity <u>PLUS</u> significant software and system integration challenges.	-1
0	F/A-22A : LOW No comparable type exists	Low Strategic Risks	F/A-18A HUG : HIGH Outclassed by Sukhoi Su-27/30/35 fighters in aerodynamic and radar performance	-1
0	F-111 : LOW Proven Tier 1 strike platform		JSF : HIGH – Tier 2 aircraft outclassed by larger Tier 1 Sukhoi Su-27/30/35 fighters in aerodynamic performance	-1

Score	Australian Industry Solution (Proposed 2001)	Capability, Cost, & Project Risk Metrics	Current Defence Plans	Score
+1 / 0 / -1 [1]	2008 Onwards [2]		2010 to 2018 / 2018 Onwards	+1 / 0 / -1
0	F/A-22A : None	No Strike Capability Gap	F/A-18A HUG : Significant Gap. Reduction of precision munitions delivery capability by up to 62.5%. Refer Figure 3 of Parliamentary Submission, “Air Combat Capability”, by A G Houston, 04 June 2004. Defence decision to exclude F-111 from Air 5418, has made gap deeper and wider.	-1
+1	F-111 : Already has MIL-1760 smart weapons bus making integration of Air 5418 FOSOW and JDAM easy (and cheap). Is not dependent on refuelling tankers to provide long range strike capability to 1,000 NMI.	No Strike Capability Gap	JSF : Ongoing Gap. Up to 37.5% reduction compared with Defence 2000 White Paper guidance.	-1
+1	F/A-22A : None. Superior in all respects to all opposing aircraft [9] out to 2025 and beyond.	No Air Superiority Gap	F/A-18A HUG : inferior speed, agility, range vs Sukhoi Su-27/30/35; significant dependency on AEW&C and tankers to provide useful capability	-1
0	F-111 : Requirement met by F/A-22A air dominance fighter capabilities	No Air Superiority Gap	JSF : Inferior speed, agility, and range when compared against Sukhoi Su-27/30/35 family of aircraft, particularly post 2010 configurations; definitely post 2015 evolved growth variants	-1

Score	AUSTRALIAN INDUSTRY SOLUTION (PROPOSED 2001)	CAPABILITY, COST, & PROJECT RISK METRICS	CURRENT DEFENCE PLANS	Score
+1 0 -1 [1]	*2008 Onwards* [2]		*2010 TO 2018*	+1 0 -1
			2018 Onwards	
+1	**F/A-22A : None** ***"The F/A-22 will be the most outstanding aircraft ever built. Every fighter pilot in the Air Force would dearly love to fly it."*** **Air Chief Marshall Angus Houston, August 2004**	**No Air Defence Gap**	**F/A-18A HUG : Considerable Gap** **Unsuited for bomber and cruise missile defence due to limited endurance, limited missile payload and limited supersonic speed**	-1
0	**F-111 : Evolved F-111 capability suitable for bomber intercept, cruise missile defence and ISR/Electronic Attack in addition to established strike roles due to excellent endurance, superior payload, high speed and advanced radar capability[10].**		**JSF: unsuited for bomber and cruise missile defence due to limited endurance, limited missile payload and limited supersonic speed. The operational JSF is intended to be a battlefield strike interdiction / close air support aircraft with some self defence capabilities[11].**	-1
TOTAL NUMBER OF METRICS = EIGHTEEN (18) **A score of zero (0) means the air combat capability system meets or achieves all the defined metrics.** **A negative score means the air combat capability system fails to meet one or more of the metrics.** **A positive score means the capability system significantly exceeds the requirements of one or more of the metrics.**				
+7	**2008 Onwards** **SUPERIOR OUTCOME**	**NETT ASSESSMENT SCORE TOTALS**	**INFERIOR OUTCOME-: 2010 TO 2018**	-16
			INFERIOR OUTCOME : 2018 Onwards	-13

ENDNOTES :

1 Allocation of scores based on a Parametric Analysis Scoring System which uses –1, 0 and +1 as a way of establishing an objective means of comparison. Defence should be invited to submit its own scores, using this system in keeping with the following guidance:

- +1 Subject model significantly significantly exceeds the requirement by some degree or embodies more than the stated metric;
- 0 Subject model meets the stated metric or the metric is not applicable to that model; and,
- –1 Subject model does not achieve or embody the stated metric.

2 Response to Defence Request for Proposal – "Project Air 6000 Force Mix Option Market Survey", DTC Air 6000 Technology Group Submission of 25 January 2002 and supporting proprietary Industry Proposals submitted in accordance with the Defence Capability Systems Life Cycle Management Guide, December 2001, after meeting with Air6000 Project Office personnel who sought further, detailed information to support their recommendation of the Evolved F-111 Option for Stage 3 of Air 6000.

3 AMARC – Aerospace Maintenance and Re-generation Center at Davis-Monthan AFB, Tucson, Arizona, USA. Over 200 F-111s remain mothballed at AMARC.

4 Since the experts in computer science (in particular, in the artificial intelligence domain) can't agree on when the capability for safe and effective autonomous operation of high risk, lethal assets in demanding, hostile environments (such as experienced in air combat) is going to be possible, with predictions ranging from 15 years to 50 years time to never, it would be fanciful and wasteful let alone naïve for the non expert to commit their integrity and public resources to a date in time.

5 The F/A-22A's APG-77 radar and the JSF's APG-81 radar share transmit-receive module technology, computer processing technology, packaging technology, and multimode capabilities, however, the F/A-22A's APG-77 is much more powerful, providing twice the detection footprint of the JSF's APG-81 radar. While the F/A-22A's APG-77 radar provides excellent bombing capability, it remains the most capable air to air radar ever built. Conversely, while the JSF's APG-81 radar provides respectable air to air radar coverage capability, it is being optimised as a bomber radar to meet the Joint Operational Requirements Document (JORD) and CAIV.

6 Defence Annual Reports 1999 to 2004 inclusive, statutory financials; Defence Capability Plan 2001-10 and subsequent including analysis of activities in current draft; RAAF Air Combat Capability Paper – A Houston, 04 June 2004; ASPI Strategic Insight – 'Is the JSF good enough' – A Houston, August 2004; Air Power Australia - A FAREWELL TO ARMS - REVISITED, P A Goon., January 2005; ADA Defender - Winter 2005 – 'Affordability and the new air combat capability', P A Goon.

7 Analysis and present value (2004) calculations of total operating expenses for the F/A-18A HUG only taken out to 2015 since fleet numbers start to drop off due to fatigue and maintenance related lifing issues shortly after 2014 (on the basis of historical flying rate and fatigue damage accrual rates which, if reduced, will effect preparedness).

8 RAAF Air Combat Capability Paper – Air Force Submission to Joint Standing Committee on Foreign Affairs, Defence and Trade dated 04 June 2004. Refer Figure 2 – F-111 Cost of Ownership (Cash) and Table 1 – Ten Year Cost of Retaining F-111 in Service. Cash flow profile figures are discounted to Present Value (2004) dollars using the same discount factors (having applied escalation factors, where appropriate) in the analysis and comparison of both models.

9 The design aims of the original F-22A, defined in the 1980s, provided capabilities to defeat opposing next generation fighters and bombers. By the early 1990s these aims expanded to include high survivable strike capabilities, resulting in redesignation to the F/A-22A. Over the last five years these capabilities have been further expanded to include intelligence, surveillance and reconnaissance in high threat situations – the F/A-22A will thus absorb much of the role performed until the 1990s by the SR-71A.

10 The earliest design aims of the original F-111 program, defined during the early 1960s, were to provide a bomber for the US Air Force and an interceptor for the US Navy, to protect naval forces from Soviet bombers and cruise missiles. As the F-111 proved too large for aircraft carrier deployment, only the bomber variants were built.
The F-111 thus retains the endurance, payload and high speed required to provide defence against bombers and cruise missiles. The Evolved F-111S proposal exploits this inherent capability to expand the utility of the F-111. Refer Parliamentary Submission entitled 'Evolving Force', C Kopp and A Cobb, October 2003 and 'Rationale'.

11 While the JSF is often loosely described as 'multi-role', its performance and avionics capabilities are mostly weighted to provide battlefield support capabilities for ground troops rather than capabilities to defeat opposing air superiority fighters, opposing bombers and provide long range strike. In US service, the JSF is planned to replace the AV-8B Harrier and A-10 Thunderbolt II, as well as F-16s and early model F/A-18s, all aircraft types used exclusively or mostly for supporting ground troops since 1995.

7 Annex C - Analysis Predictions Provided to Defence (Since May 1998)

1. The impact of acquisitions of Su-27SK by China and Su-30MKI by India was accurately predicted. An unpredicted development was the acquisition of the Su-30MKM series by Malaysia.

2. Acquisitions of Su-30MKK by China were accurately predicted. An unpredicted development was the development and acquisition of the Su-30MK2 by the PLA Navy air arm.

3. Acquisitions of A-50 derivative AEW&C aircraft by China and India were accurately predicted. Unpredicted developments were the current intent by Malaysia to acquire AEW&C aircraft, US intervention to block Israel's sale of the A-50I to China, and US approval of the sale of the A-50I to India.

4. Acquisitions of Il-78 Midas derivative tanker aircraft by China and India were accurately predicted. An unpredicted development was the deployment of several squadrons of indigenous Chinese H-6U/DU tanker aircraft.

5. Acquisitions of further S-300 variant long range Surface-to-Air Missile systems in the wider region were predicted. Indonesia's interest in the S-300PMU series was not predicted.

6. Sukhoi Su-27/30 radar signature reduction measures were accurately predicted.

7. Sukhoi Su-30 N-011M BARS phased array radar capabilities were understated. The Su-27 NIIP Pero phased array block upgrade to the NIIP N-001 radar was not predicted.

8. The Su-27SKU digital glass cockpit upgrade was correctly predicted.

9. The regional proliferation of 'counter-AWACS' variants of the Kh-31R missile was correctly predicted.

10. The regional proliferation of 'counter-AWACS' variants of the KS-172 missile was correctly predicted. India's intent for co-production of the KS-172 was not predicted.

11. The susceptibility of the Wedgetail AEW&C to long range 'counter-AWACS' missiles was accurately predicted.

12. The emergence of anti-radiation variants of the Russian R-77 (AA-12) BVR missile was correctly predicted, but the development of heat-seeking variants was not predicted.

13. The emergence of the improved OLS-30 Infra Red Search Track set on the Su-30MK was correctly predicted.

14. The emergence of third generation optical seeker technology for the Russian R-73/74 family of WVR missiles was not predicted.

15. Strike capability growth in the F-22A was correctly predicted, but did not predict the extent of this growth, or planning to make all intended 380 F-22A fully strike capable.

16. The emergence of the FB-22A strike aircraft was not predicted.

17. The limitations in air combat capability in the Joint Strike Fighter were accurately predicted, as were the underlying reasons for this being so. The emergence of the 'Export Joint Strike Fighter' variant with reduced stealth was not predicted.

18. The potential for the F-111 to be operated well beyond 2020 was not predicted. This was later determined as one of the results of the Sole Operator Program and is one of the cornerstones of the subsequent 'Evolved F-111' proposals.

19. The potential for the B-1B and F-111 to be retrofitted with supersonic cruise engines was not predicted. This was later presented in the 'Evolved F-111' proposal entitled 'Super Cruise and the F-111' and more recently for the B-1B in the Boeing response to the USAF RFI for Interim Long Range Strike Capabilities.

8 Annex D - Adverse Effects of Early F-111 Retirement

Figure 54: *RAAF F-111C departing Amberley for Red Flag exercise in the US, January, 2006 (Defence PR).*

1. **Adverse Capability Effects.**
   (a) A ≈50% reduction in aggregate RAAF striking power available.
   (b) Loss of primary long range land strike capability.
   (c) Loss of primary long range maritime strike capability.
   (d) Loss of high payload battlefield strike capability (Each F-111 ≈ $\frac{1}{2}$ B-52H heavy bomber capability).
   (e) Loss of unrefuelled persistent battlefield strike capability.
   (f) Loss of unrefuelled persistent Combat Air Patrol capability for dealing with terrorist hijackings.
   (g) Loss of potential unrefuelled persistent Combat Air Patrol capability for cruise missile interception.
   (h) Significant increase in F/A-18A fatigue life consumption should regional contingency arise.
   (i) Significant increase in tanker fatigue life consumption should regional contingency arise.
   (j) Loss of primary airborne systems and weapons integration engineering capability at Amberley WSBU.
   (k) Loss of primary engineering capability to execute 'ageing aircraft program' techniques on RAAF platforms.

2. **Adverse Strategic Effects.**

   (a) As regional Sukhoi Su-27/30 numbers and proficiency increase, a 'strategic inversion' of the deterrence relationship will arise - regional nations could challenge Australian regional intervention.

   (b) Loss of primary strategic deterrence tool for dealing with potentially hostile future regimes across wider region.

   (c) In scenario with high risk of terrorist hijackings, F/A-18 and B-707 fleet too small to protect all capitals without F-111 support.

   (d) Likely perception in US strategic circles that Australia is emulating the behaviour of EU NATO nations which downsized critical defence capabilities and shifted that burden on to the US force structure.

   (e) Loss of single highest value combat contribution to US-led coalition air campaigns.

   (f) Loss of capability to rapidly integrate and test new weapons on RAAF aircraft - cf UK in Falklands and US in Afghanistan rapidly adding new weapon types in urgent contingencies.

3. **Adverse Industrial Base Effects.**

   (a) Reduced engineering capability to extend life of other RAAF platforms using 'ageing aircraft program' techniques - F-111 provides 'critical mass'.

   (b) Loss of opportunities for domestic industry to effect import replacement through in-country upgrades on F-111 thus impacting balance of payments.

   (c) Loss of opportunity to inoculate domestic aerospace industry sector and associated systems integration industry sector from post September, 2001, global downturn.

   (d) Loss of opportunities to further add value, and further leverage the vast materiel and intellectual investment the taxpayer has made in the F-111 and its support capabilities.

   (e) Significant loss of employment in domestic systems integration and aerospace industry sector, including training positions.

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Figure 55: *RAAF F-111C aircraft during the February, 2006, Red Flag exercise in the United States (US Air Force)*

End of Submission

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