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Inquiry into Australian Defence Force Regional Air Superiority

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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.

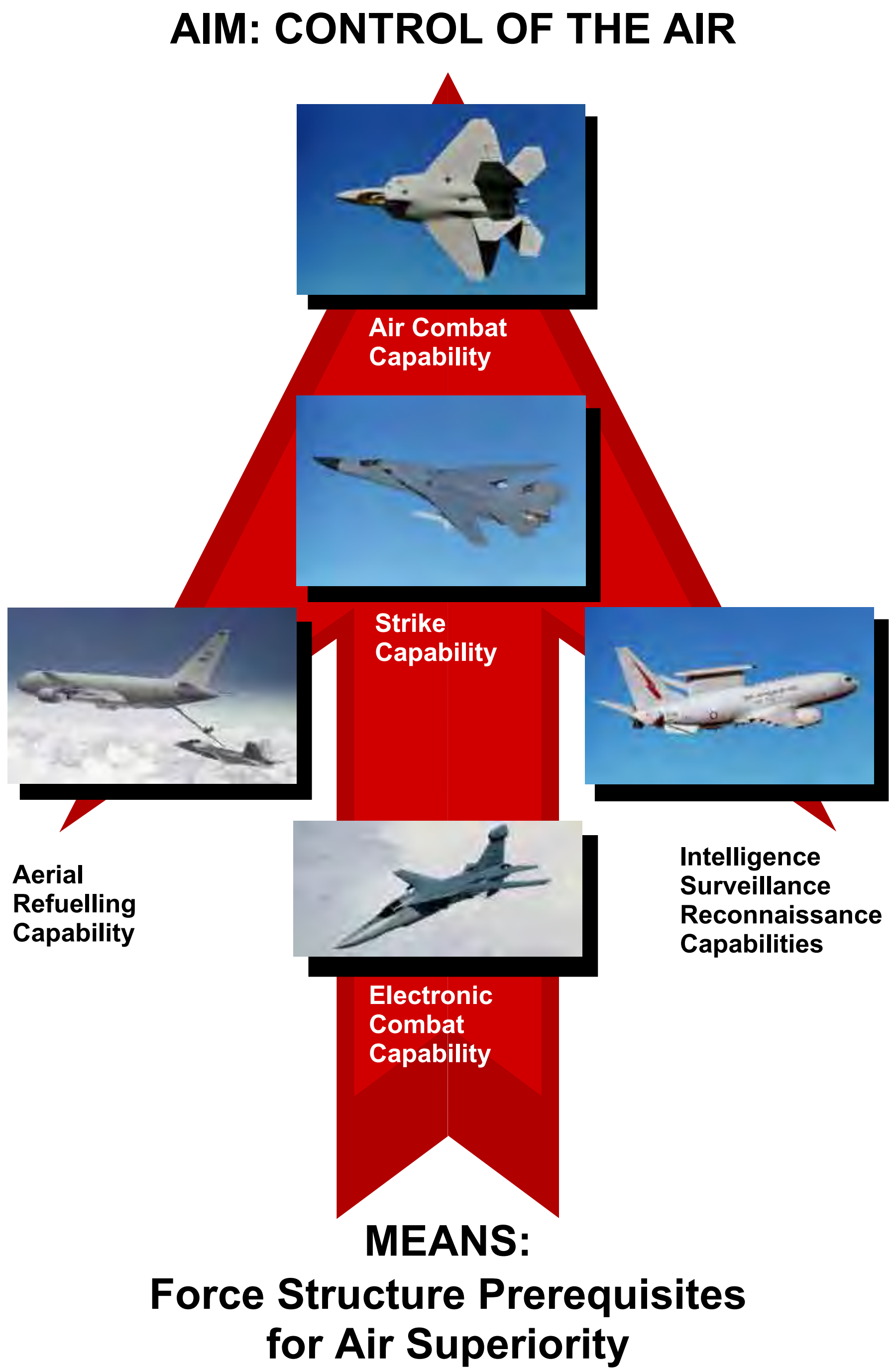


Figure 28: *Force structure prerequisites for achieving air superiority. It is important to observe that recent air campaigns, such as Desert Storm, Allied Force, Enduring Freedom and Iraqi Freedom were all 'asymmetric' in the sense that opponents of US led coalitions lacked most if not all of these 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).*

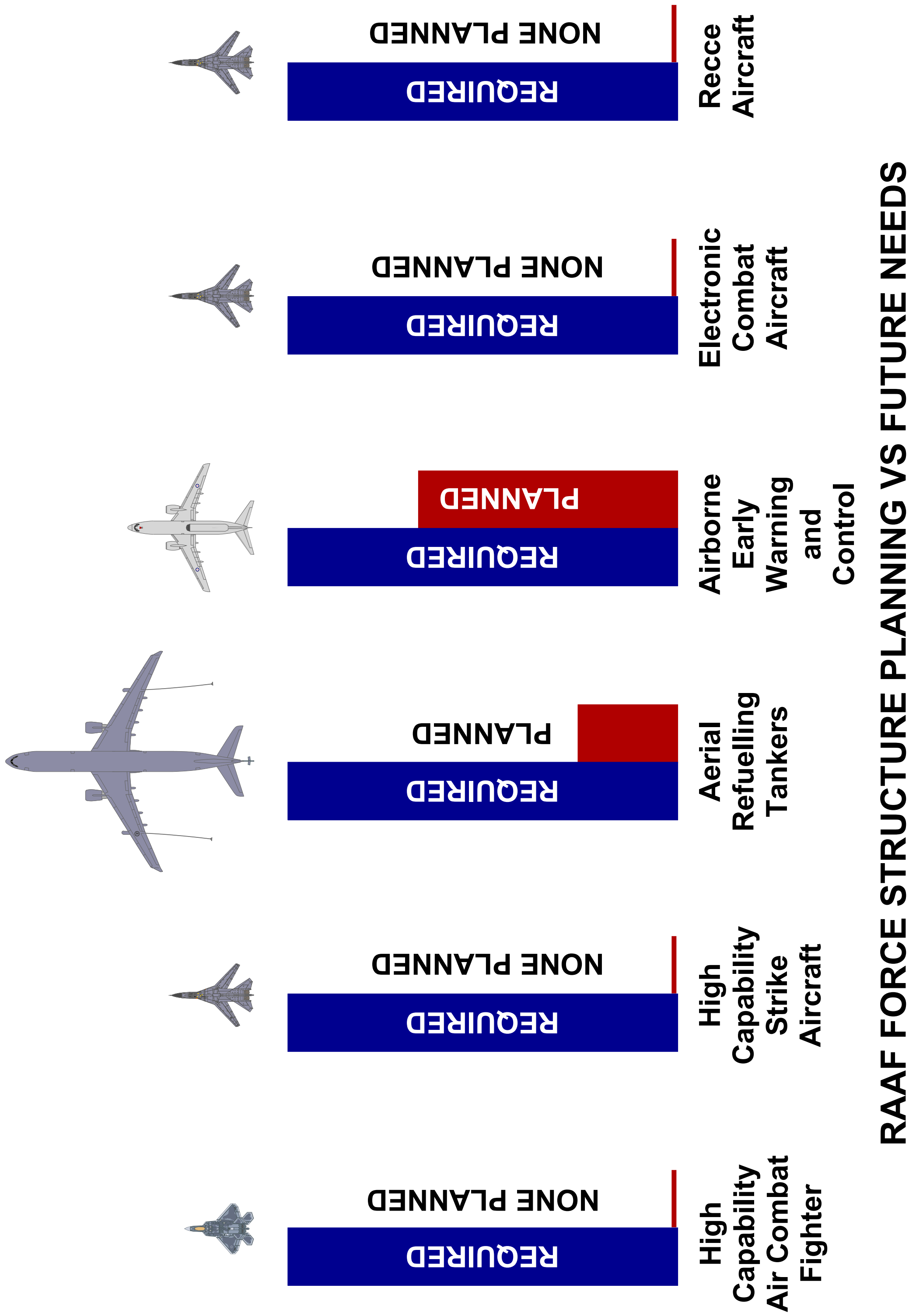


Figure 29: *This chart displays planned RAAF force structure investment vs needs arising from regional capability growth. Of the six key areas of investment, two involve inadequate investment and four no investment at all (C. Kopp).*

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

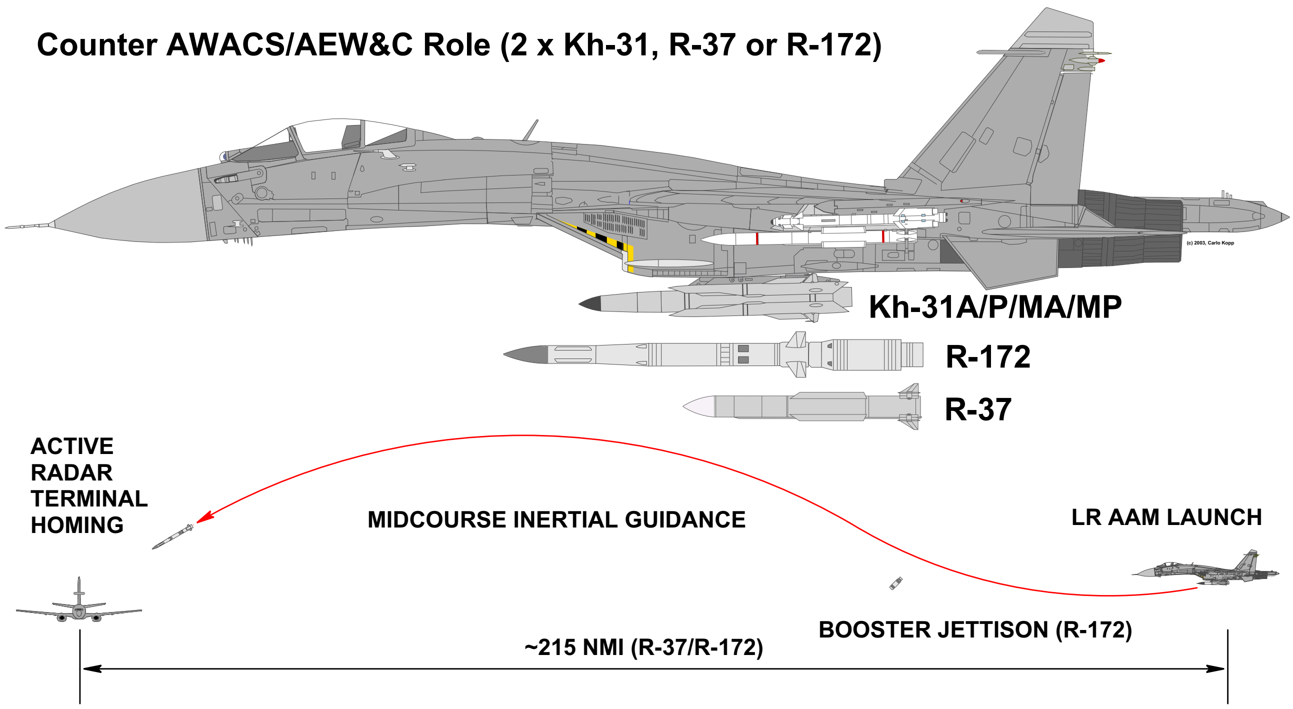


Figure 35: *The importance of Intelligence Surveillance Reconnaissance capabilities is so great, it has resulted in the evolution of specialised weapons and tactics to disrupt and destroy such systems. Russia is actively marketing very long range missiles for this purpose within the region. Without a 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.

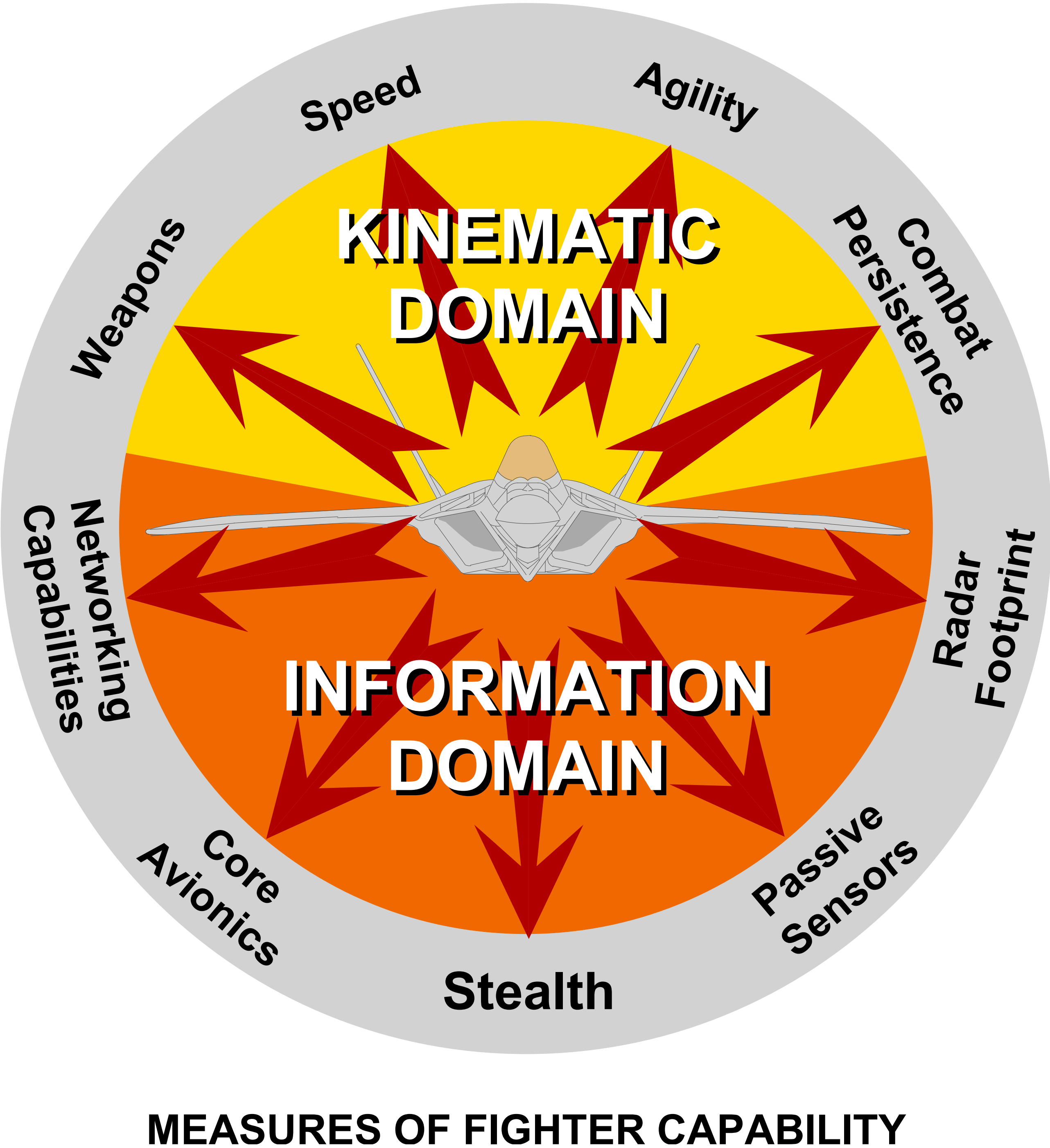


Figure 36: *Decades of experience in modern air combat allow us to identify nine key measures of fighter capability. Four of them fall into the 'kinematic domain' and afford the superior fighter the ability to gain a positional advantage over an opponent, while five of them fall into the 'information 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).*

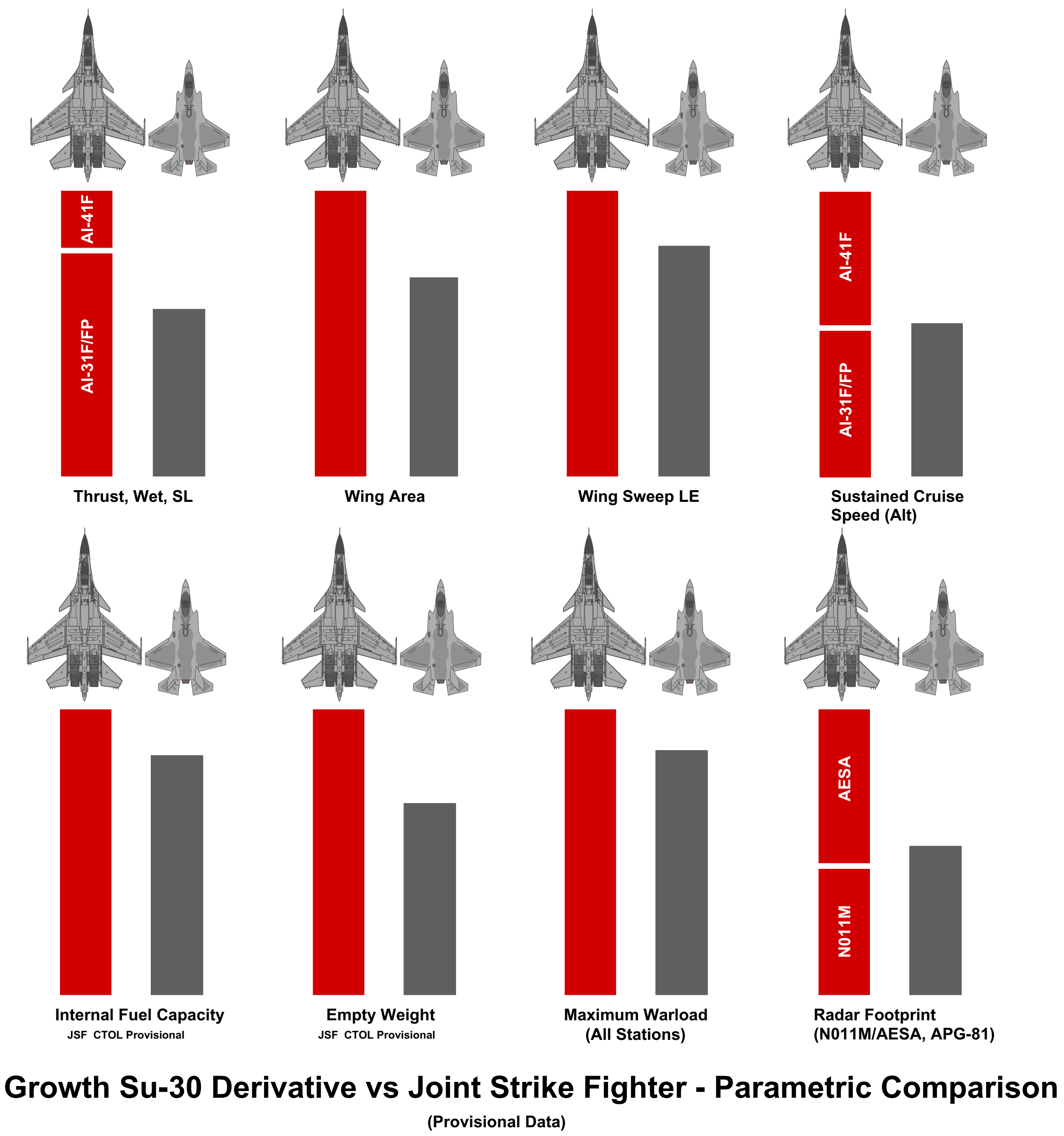


Figure 37: *This chart compares cardinal performance and capability parameters of the Joint Strike Fighter against baseline and growth variants of the Russian designed Sukhoi Su-27/30 family of fighters. Russian sources claim that a growth variant with the supersonic cruise capable Al-41F engine entered 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).*

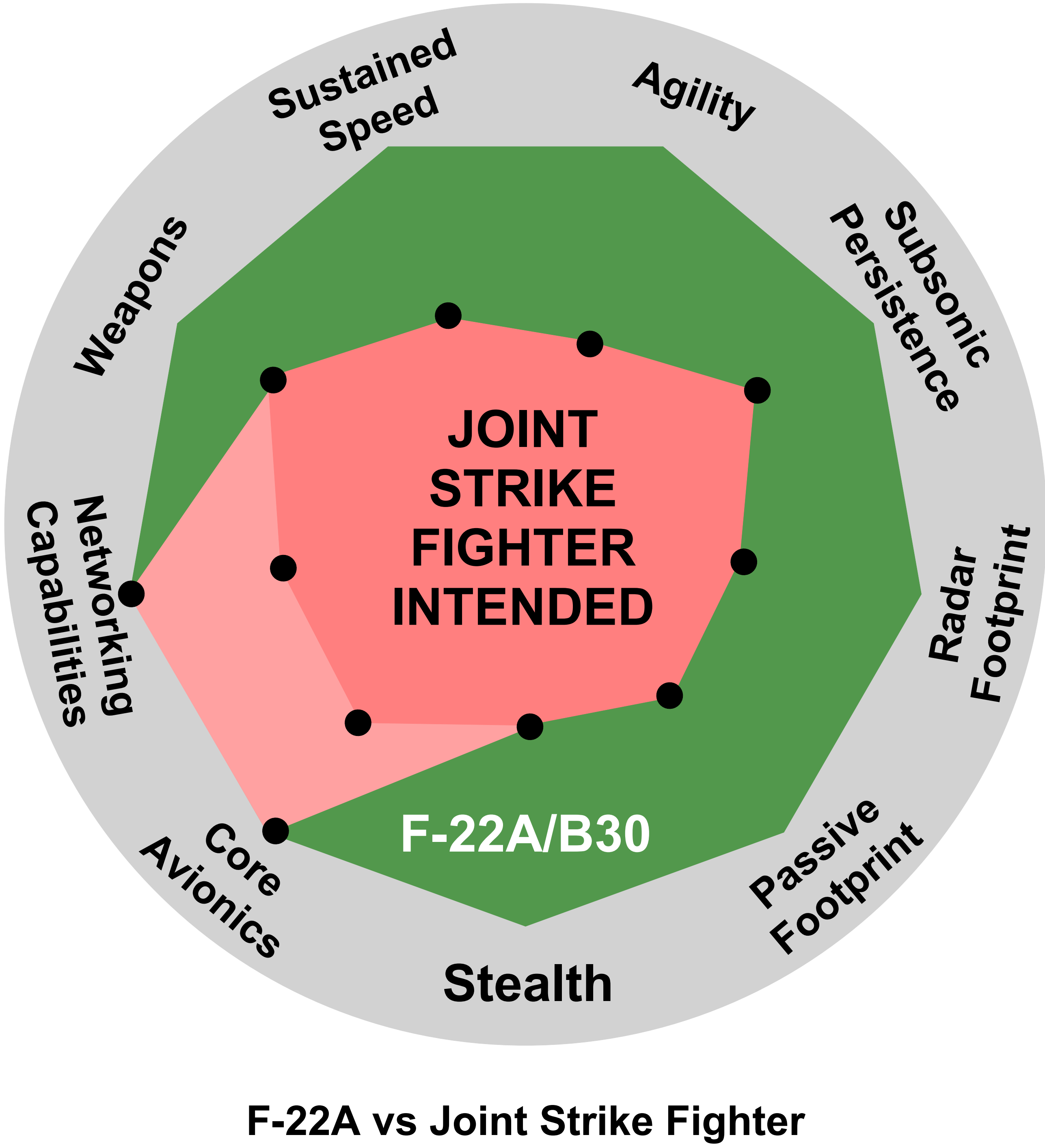


Figure 38: *Comparison of cardinal capability measures for the F-22A and the Joint Strike Fighter. While the intended Joint Strike Fighter capability matches the networking and internal computing capabilities of the F-22A, the Joint Strike Fighter falls short in its capabilities to detect targets and 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).*

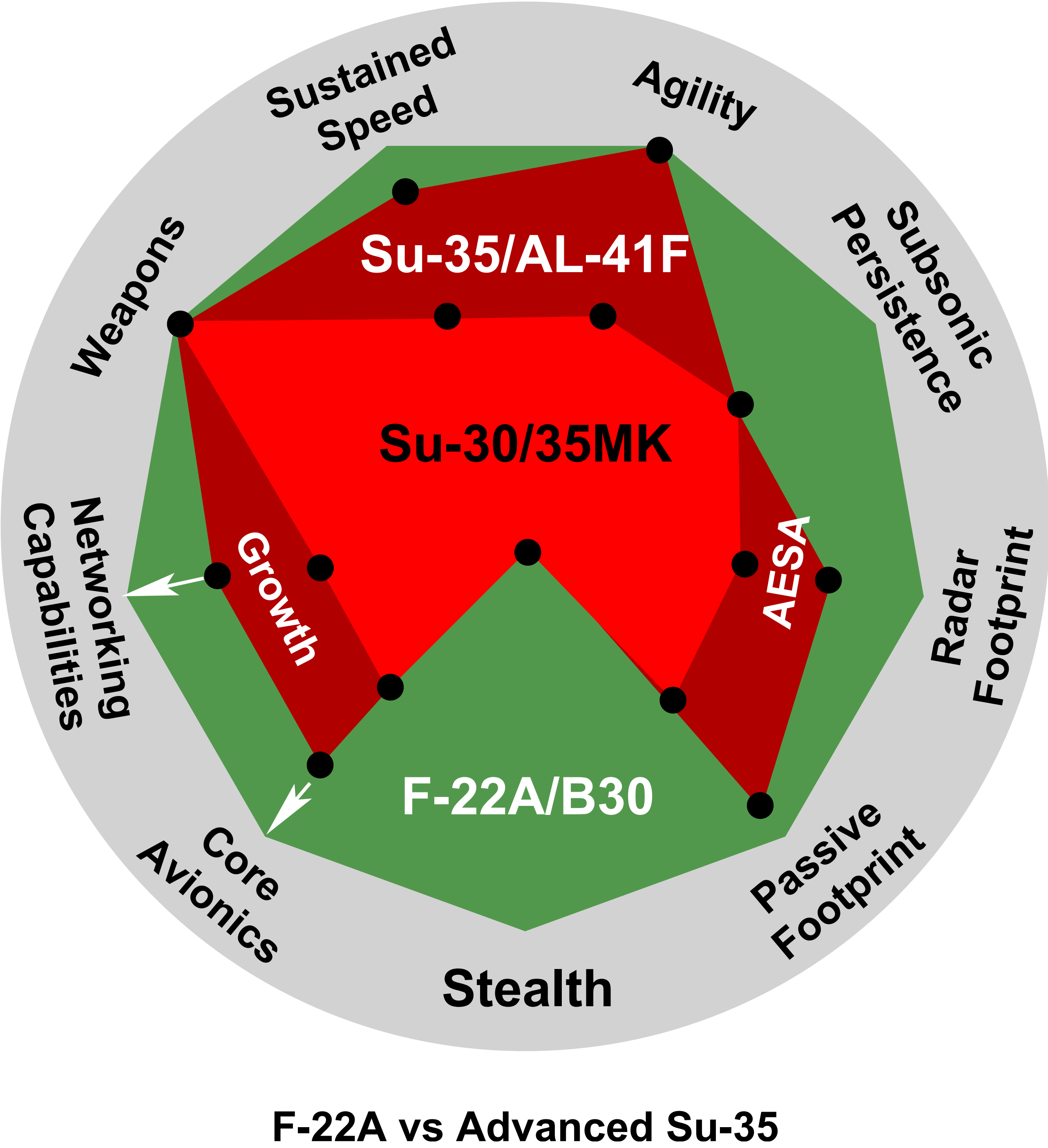


Figure 39: *Comparison of cardinal capability measures for the F-22A and advanced variants of the Sukhoi Su-30MK and Su-35. The basic Su-30MK and Su-35 can be enhanced via the installation of AL-41F supersonic cruise engines, the installation of an active phased array radar (AESA), and the enhancement 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.

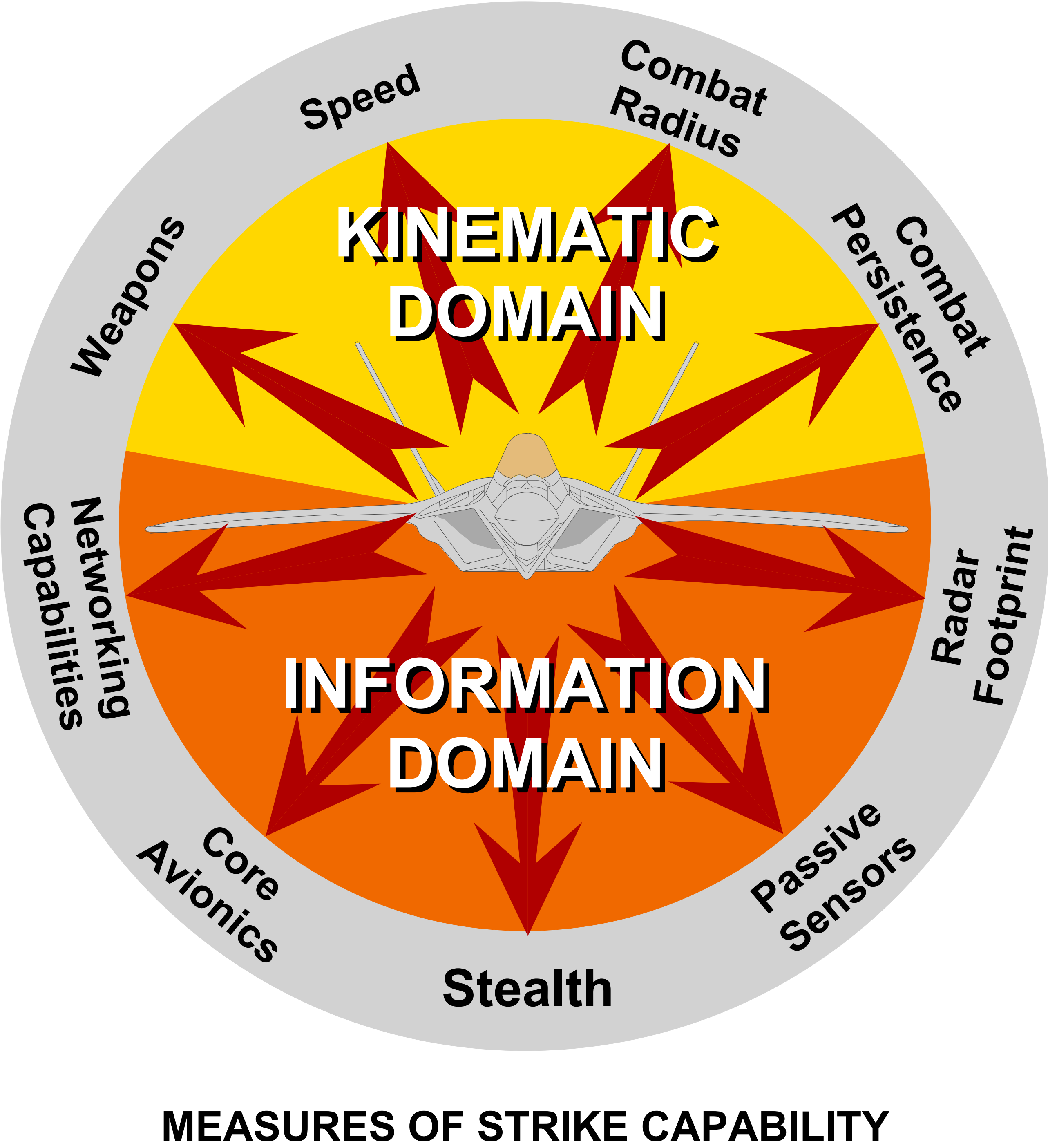
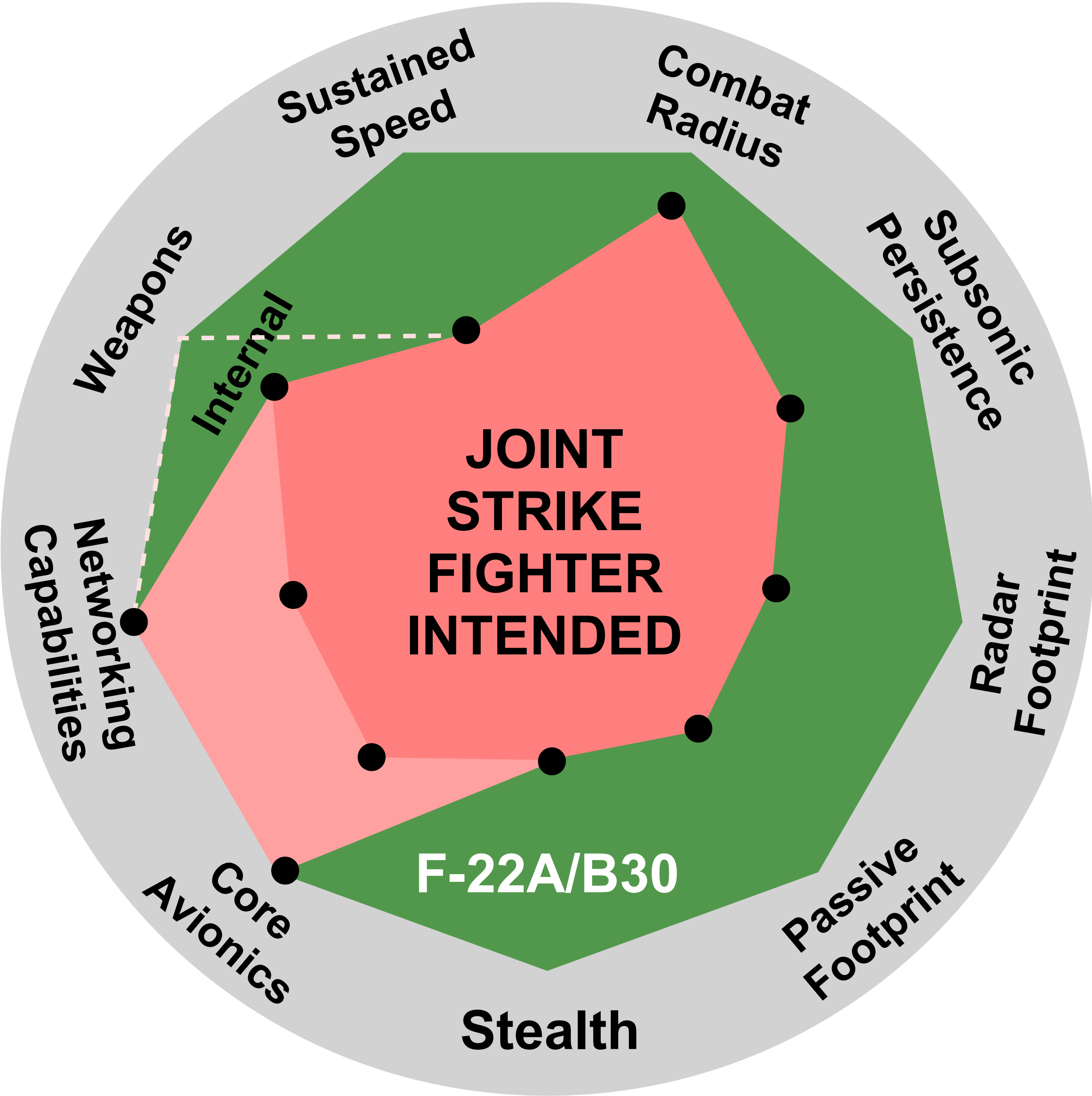


Figure 40: *Decades of experience in modern strike operations allow us to identify nine key measures of strike capability. Four of them fall into the 'kinematic domain' and afford the superior strike greater productivity and more opportunities to evade defences, while five of them fall into the 'information 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).*



F-22A vs Joint Strike Fighter
Strike Capability

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).*

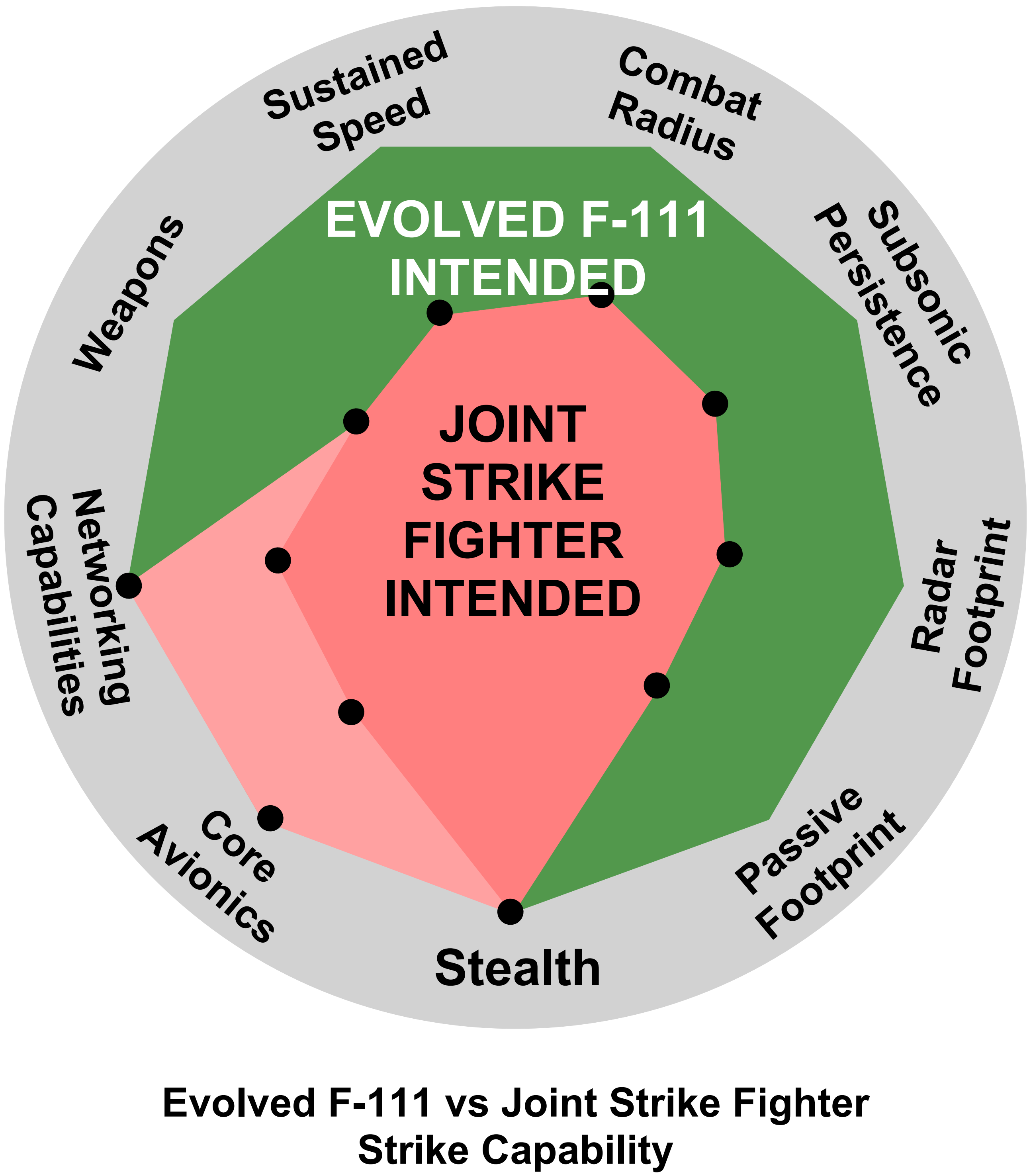


Figure 42: *Comparison of cardinal strike capability measures for the Evolved F-111 proposal and the Joint Strike Fighter. While the intended Joint Strike Fighter capability matches the networking and internal computing capabilities of the Evolved F-111, the Joint Strike Fighter falls short in its capabilities 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).*

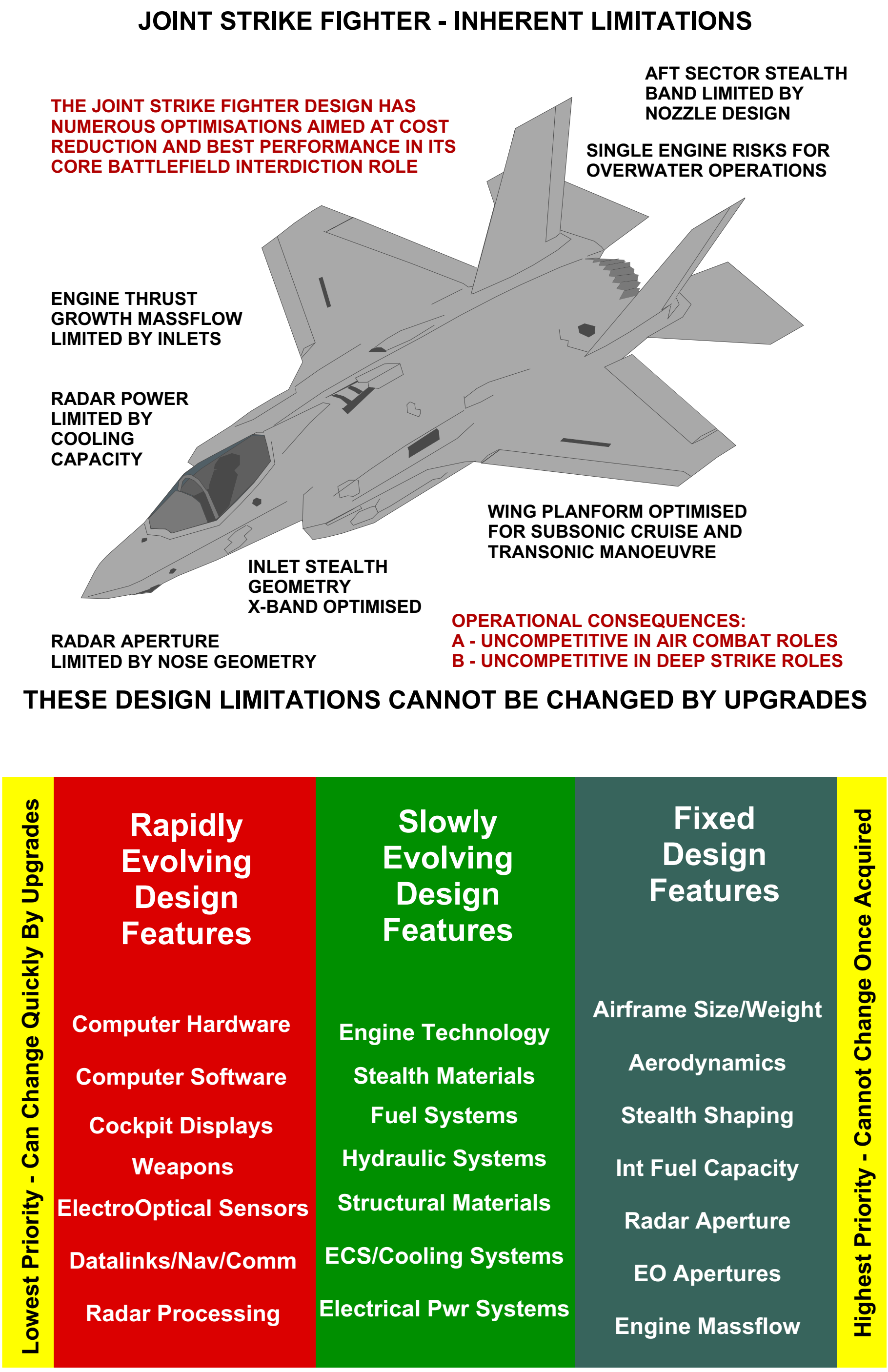


Figure 43: *The Joint Strike Fighter (upper) was designed primarily to support ground forces on the battlefield rather than defeat opposing high performance aircraft or guided missile defences, and is thus not suitable for the developing regional environment. As its limitations are inherent to the design, 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.