The Fighter Aircraft and the Future of Airpower: Reflections on the Southeast Asian Landscape

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Abstract:

The trend of replacing fighter aircraft with alternate technologies and concepts such as Unmanned Aerial Vehicles (UAVs) and ground-launched precision strike capabilities has been relentless. The maneuverability, speed and payload of fighter aircraft remain unmatched by most UAVs and this essay seeks to address the cardinal need to retain fighter aircraft while harnessing integrated air operations between fighter aircraft, other manned aircraft, UAVs, ground launchers and even satellite-based sensors.

Keywords: Airpower; Fighter Aircraft; RSAF; UAV

INTRODUCTION

On 6 September 2013, the Predator Unmanned Combat Aerial Vehicle (UCAV) successfully struck and killed a senior leader of the Islamist terror group known as the Haqqani Network.[1] In 2012, Lockheed Martin delivered the 200,000th Guided Multiple Launch Rocket System (G-MLRS) rocket, a combat proven all-weather precision strike capability boasting ranges up to 70km. The trend of replacing fighter aircraft with alternate technologies and concepts such as Unmanned Aerial Vehicles (UAVs) and ground-launched precision strike capabilities has been relentless. Does this mean that the fighter aircraft will no longer be relevant in the modern Air Force arsenal? This article will make an assessment of the truth behind this trend, and reflect in particular on the South East Asian landscape.

CONTINUED RELEVANCE OF MANNED FIGHTER AIRCRAFT

Competing Developments

Recent conflicts such as the 2006 Lebanon War reveal a shift in airpower's center of gravity away from fighter aircraft. During the war, the use of small UAVs by the Israelis in Bekaa Valley lead to an overwhelmingly

Two F-22s during flight testing, the upper one being the first EMD F-22, "Raptor 01."

favorable kill ratio of nineteen SAM batteries and 86 Syrian aircraft to one Israeli aircraft.[2] This shift was fueled by two main reasons: 1) prohibitively high and escalating *costs* of fighter jets paired with the increased public scrutiny of government military spending,[3] and 2) the development of *alternative technology and concepts* to the fighter aircraft such as the Unmanned Aerial Systems/Vehicles (UAS/UAVs), and ground launched strike capabilities such as the G-MLRS and ballistic/cruise missiles.

Rising Cost

Today the cost of an F-22 Raptor is a staggering US$377 million. This includes development and production spending costs divided by the 187 jets built, but does not include the lifecycle cost—the price of fuel, spare parts and maintenance during the jet's projected 40 year lifespan. Adding the life cycle cost would mean that each F-22 costs US$678 million to design, produce and operate.[4] This stands in stark contrast to the US$18.8 million and US$31.1 million per unit cost of the F-16C/D Fighting Falcon (or Viper) and F-15E Strike Eagle respectively.[5] It is the escalating and prohibitive cost of fighter aircraft that drives governments to look at cheaper alternatives, especially if the political will for a capable military force wanes.

Increased Scrutiny on Military Spending

Singapore has always placed unwavering political will behind the need for a capable defense force. Then-Prime Minister Mr. Lee Kuan Yew led the Singapore Government to commit up to 6% of Singapore's GDP on defense, citing the cardinal need for defense as the cornerstone for sovereignty and socio-economic success. In practice, this commitment has not faltered. In 2013, the Ministry of Defense (MINDEF) was allocated a budget of SG$12.34 billion,[6] more than 4% of the 2012 GDP.[7]

However, there are indications that the commitment to defense spending may be increasingly questioned by many Singaporeans. While MINDEF and the Singapore Armed Forces (SAF) have always adopted a prudent approach of investing only in what is needed, the public may increase their scrutiny of the MINDEF budget in favor of spending on socio-economic areas. During the 2012 Committee of Supply debates on the Singapore budget, some Ministers of Parliament (MP) asked if Singapore could reduce her defense posture and preparations because of the SAF's previous accomplishments.[8] While Singapore's Minister for Defense strongly defended and justified the need for continued commitment towards military spending, there might come a time when this position is untenable in the face of competing national needs and the higher operating costs of advanced military technology, in particular, fighter aircraft. Even the United States (US) Defense Department had to shut down F-22 production in 2012 because of the skyrocketing costs, a decision made by Congress.[9]

Alternatives to Fighter Aircraft

Unmanned Aerial Vehicles, or drones, have become today's weapon of choice in "dull, dirty and dangerous" missions that fighter aircraft traditionally performed. UAVs are capable of long loiter time and constant surveillance in *dull* missions which fighter aircraft cannot match. The risk of contamination to the pilot in the fighter cockpit means that UAVs are also preferred for *dirty* missions involving possible radiological, chemical or biological contamination. In *dangerous* missions such as probing enemy air defenses or operating over targets where the pilot has a high risk of being shot down, UAVs are also the preferred options.

An MQ-9 Reaper taking off in Afghanistan.

An example of a "dull, dirty and dangerous" mission is *counterinsurgency*. The long loiter time and constant surveillance required to locate fleeting insurgent targets make UAVs preferred over fighter aircraft. In the past nine years, the Pentagon has already increased its drone fleet thirteen-fold and spends at least US$5 billion a year adding to it. Moreover, the frequency of drone strikes on insurgents in Pakistan's Federally Administered Tribal Areas has risen ten-fold since George W Bush's presidency.[10]

Besides UAVs, alternative strike options to fighter aircraft such as the Guided Multiple Launch Rocket System (G-MLRS) are also rapidly emerging, with Lockheed Martin delivering the 20,000th GMLRS rocket in 2012.[11] With a range of up to 70km, an all-weather and precision strike capability, and a combat reliability rate of 98%, G-MLRS looks likely to replace strike fighters for short-range strikes. The range and accuracy of alternative strike technology is constantly on the rise, with Boeing currently developing a Ground-Launched Small Diameter Bomb (SDB) deployed using MLRS launchers.[12] The development of such technologies and concepts may portend a reduction of the traditional role of fighters in strike missions.[13]

Long-range alternative strike options like ballistic and cruise missiles are also attractive to many nations,[14] because they can be used effectively against adversaries with formidable air defense systems, where attacks with fighter aircraft would be impractical or too costly. In addition, missiles can be used as a deterrent or an instrument of coercion. Even a limited use of these weapons can produce devastating effects when armed with chemical, biological, or nuclear warheads.[15]

THE CASE FOR FIGHTER AIRCRAFT

UAVs and alternative strike options may steal some thunder from fighter aircraft, but the fighter aircraft still remains the backbone of Counter Air Operations (including sweep/strike/escort roles). Moreover, it retains relevance in Air Intelligence, Surveillance and Reconnaissance (AISR) missions, where UAVs have largely established themselves, due to several important advantages.

Situational Awareness (SA)

The fighter pilot can rapidly scan his surroundings with the aid of SA enhancing devices like the Joint Helmet Mounted Cueing System (JHMCS), pick out relevant details, and react in a near-instantaneous and intuitive manner. The fighter pilot's accumulation of experience also allows him to utilize his SA to make sound and forthcoming decisions in almost any real time situation.

On the other hand, the UAV and its operator have to rely on onboard sensors to reconstruct a virtual situational picture. Besides being blind to anything that lies outside the field of vision of the aircraft's sensors, they also suffer from lag due to latency. The few seconds of latency between each step of the Observe, Orient, Decide and Act (OODA) loop can be decisive in time critical and reactive missions such as Within Visual Range (WVR) "dogfights" in Counter Air Operations.

Take for example a WVR fight against an unidentified aircraft that pops up in close quarters, a likely occurrence due to the fog of war. In such a scenario, visual identification or identification through airborne sensors like targeting pods is required before an engagement decision is made. The few seconds of lag between identification and engagement is all it takes for the enemy to make their own engagement decision first, resulting in a sure loss scenario. Lag caused by latency in the UAV, coupled with the reduced level of situational awareness, leaves them significantly disadvantaged in a WVR fight.

Maneuverability, Speed and Payload

The maneuverability, speed and payload of fighter aircraft remain unmatched by most UAVs. Most current UAVs are only capable of simple maneuvering. For those with improved maneuverability, more sophisticated flight control systems are necessary, which translates to a heavier overall aircraft weight and shorter loiter time.

In terms of speed, most lightweight UAVs operate below 100kts. The fastest operational UAV is the MQ-9 Reaper which has a max speed of about 260kts. This pales in comparison to fighter aircraft which are capable of speeds in excess of 600kts. A UK firm has promised the world's first supersonic UAV, the Taranis. However, the trade-off between speed and endurance still applies, because the weight of the engine and aircraft structure needed to support supersonic flight significantly reduces the new UAV's endurance.

In terms of payload, current UAVs today carry much less than even the relatively lightweight F-16—the MQ-9 reaper carries a maximum of 3,800lbs as compared to 6,000lbs for the F-16.

However, with advances in technology, it is likely that unmanned platforms will one day match fighter aircraft in terms of maneuverability, speed and payload. Already, fighter aircraft such as the F-4 and F-16 have been converted into unmanned QF-4 and QF-16s,[16] effectively creating UAVs with the same maneuverability, speed and payload as fighter aircraft. Therefore, the more important question lies in the value of making UAVs as maneuverable and high performing as fighter aircraft, because they lose their existing advantage of having a longer loiter time. Eventually, it may boil down to the need for high situational awareness versus the risk of having a pilot in the cockpit.

Fighter aircraft are equipped with sophisticated defense mechanisms such as Electronic Countermeasures, giving them high survivability in combat. UAVs on the other hand are vulnerable with few, if any, defense mechanisms.

Survivability

Fighter aircraft are equipped with sophisticated defense mechanisms such as Electronic Countermeasures (Chaff/Flare/Radar Warning Receivers or RWRs), giving them high survivability in combat. UAVs on the other hand are vulnerable with few, if any, defense mechanisms. UAV survivability is heavily dependent on low profile due to small size. However, as UAVs become bigger in the bid to increase maneuverability, speed and payload—or to put defense mechanisms on board—they will become more detectable and thus more vulnerable. According to statistics, UAV survivability seems to be higher in combat. However, these statistics were gathered when UAVs were deployed over Iraq and Afghanistan—where air dominance was enforced by regular fighter aircraft—which makes them unreliable.[17]

Vulnerability in an Electronic Warfare (EW) Environment

With the increased use of EW in combat, fighter aircraft may have their radars or even data links jammed. Nonetheless, fighter aircraft are also equipped with Electronic Countermeasures such as advanced radar modes to counteract the jamming. In the jamming environment, fighter aircraft remain effective through passive sensors like the Infrared Search and Track (IRST) and Electro-Optic/Infrared targeting pods. If all else fails, the jam-proof pilot in the cockpit will still be able to operate autonomously.

On the other hand, UAVs are critically dependent on secure two-way data link communication. If the link is broken or even temporarily disrupted, the remote pilot may lose control of the aircraft. In the EW environment, Global Positioning System (GPS) or data link jamming may result in a loss of connectivity or degrading of sensors that will render UAV ineffective in combat. Even the highly secretive RQ-170 of the United States Air Force (USAF) was supposedly brought down in this manner by the Iranian military.

Cost Effectiveness

A typical Fifth Generation fighter aircraft may cost over $100 million, but it has a useful lifespan of 30 years or 40,000 flight hours, and longer if upgraded. This is significantly more than an average UAV's lifespan. UAVs are less technically robust, and some countries accept peacetime losses due to technical problems, loss of command links, loss of control, bad weather and other causes as part and parcel of UAV operations. While such losses may be tolerable for small and inexpensive UAVs, they can scarcely be accepted in the case of sophisticated Unmanned Combat Air Vehicles (UCAVs) which rival manned fighters in cost. This is not to mention the lower survivability of UAVs in combat compared to the fighter aircraft. Against a capable adversary, UAVs are likely to experience high loss rates that quickly nullify the lower unit costs they offer over manned aircraft.

In terms of usefulness, the fighter aircraft is able to autonomously execute a wide variety of missions. In contrast, even the most advanced UCAV currently available can only perform a very limited range of missions. A single MQ-9 Reaper UCAV costs about US$36 million while the Boeing X-45 UCAV is estimated to cost about US$25 million apiece. Add the costs of the ground control station, satellite data-links and other subsystems essential for combat operations, and the total cost becomes comparable to that of fighter aircraft.[18]

An assessment of cost effectiveness between the fighter aircraft and UAVs based on their useful lifespan and range of missions reveals that fighter aircraft are likely to remain the preferred choice for complex and varied missions.

Limitations of Alternative Strike Solutions

Cruise missiles may be preferred over fighter aircraft for long-range strikes because they are difficult to detect. Moreover, they are able to carry chemical, biological and nuclear warheads.

There are political and strategic dangers associated with advocating the use of cruise missiles. Besides creating deterrence by threatening a full-scale retaliation that will inflict irrevocable damage on the adversary, there are very few effective ways of defending against these missiles. Nations must procure even more destructive weapons to threaten the belligerent party, possibly triggering an arms race that will be reminiscent of the nuclear standoff between US and Russia. The world still remembers the day it came to the brink of global annihilation on Black Sunday during the 1962 Cuban Missile Crisis—fortunately, the situation was de-escalated and a series of non-proliferation treaties ensued.

Before cruise missiles rose in popularity, long-range ground launched precision strike technology existed in the form of ballistic missiles. Ballistic missiles carry a payload which descends to the target following a free-fall ballistic profile, whereas cruise missiles are engine powered and cruise all the way to their target.

Today, neither Russia nor the United States produce or retain any medium or intermediate range ballistic missile systems because they are banned by the Intermediate-Range Nuclear Forces Treaty (removing all missiles with a range of 500km-5,500km), which entered into force in 1988. In 2011, the New Strategic Arms Reduction Treaty which limits the United States and Russia to no more than 1,550 warheads each (including those on intercontinental ballistic missiles, submarines, and heavy bombers) entered into force. However, there are no treaties today that cover missiles with a range of less than 500km, which is where cruise missiles come into play. Even in the recent Syrian crisis, the most high profile weapon the US threatened to employ against the regime was the Tomahawk cruise missile.

Alternative strike solutions like ballistic and cruise missiles have proven to be too effective and too dangerous to use, and it is in the interest of every rational nation to avoid opening up the Pandora's

Box and repeating a grave historical mistake. Procurement of these alternative strike solutions is extremely politically sensitive and would likely spark an uncontrolled arms race. While G-MLRS and ground-launched SDBs seem more palatable when compared with ballistic and cruise missiles, they are equally politically unacceptable in regions with close and contested national and geographical boundaries. The dire consequences of relying solely on ballistic and cruise missiles make fighter aircraft the preferred defense solution capable of projecting calibrated levels of deterrence.

REGIONAL FIGHTER AIRCRAFT DEVELOPMENTS AND AIRPOWER LANDSCAPE

Fighter aircraft have been a mainstay in the airpower landscape of regional Air Forces and will remain so for at least the next three decades. Regional Air Forces have not seen a significant overhaul of their fighter orbit in the past two decades, attributable to the limited defense budget of each nation as well as the high costs of the aircraft. Nevertheless, the varied combination of Generation 2 to 4 fighters (see Table 1 for classification) covers a wide spread of roles that still form the bulk of the region's airpower equation (see Table 2 for details).

Before proceeding further, we need to first clarify a Douhetian misconception: airpower does not equate only to strike missions, nor does it refer only to fighter aircraft. Airpower is in fact a large equation that denotes 1) a projection of power or influence 2) using aircraft, helicopters, UAV or missiles that traverse the medium of air (including space),[19] 3) to achieve strategic, operational or tactical objectives (including supporting land and naval services).

While non-fighter platforms are also part of this equation, fighters cover almost all the major roles in airpower in this region—Counter Air Operations (CAO), including sweep, strike and escort missions), Counter Surface Operations (CSO) both on land and sea (Close Air Support, Battle Air Interdiction, Maritime Air Interdiction and Maritime Close Air Support), Reconnaissance, and Air Defense missions.

Second, we need to understand the most widely accepted categorization of fighter aircraft—by generations. Generation is not assigned by time frame, but by the capabilities that the fighter aircraft design possesses:

Based on this classification, it is observed that the region's fighter aircraft orbit spans Generations 2 to 4: We can see that regional nations are also keen to continue employing fighter aircraft as their "teeth," given their respective Next Generation fighter programs such as Indonesia's development partnership with South Korea on the KF-X program, Malaysia's Multi-Role Combat Aircraft (MRCA) program and Singapore's security cooperative partnership in the F-35 program. These programs will bring in more Generation 4 to 5 fighters into the region within the next twenty years, as well as corollary capabilities and concepts.

These new aircraft and their accompanying capabilities and concepts enhance the fighter aircraft's effectiveness in performing its role in the airpower equation. These concepts notably include stealth/low observability, data link/networks, advanced electronic warfare suites and advanced fighter aircraft munitions.

The key to stealth is the ability to penetrate heavily defended radar networks and employ precision weapons on strategic targets.

Stealth

Stealth technology is touted to enter the region within the next ten years via the F-35 and KF-X. Malaysia's MRCA may also bring in the Generation 4+ Eurofighter Typhoon or Rafael, which boasts a reduced Radar Cross Section (RCS) although not fully stealth capable. The Sukhoi PAK FA T-50 and China's J-20 and J-31 are also wild cards that may bring stealth to the region.

Generation	Characteristics	Examples
1	Jet propulsion	F-80, German Me262
2	Swept wings; range-only radar; infrared missiles	F-86, MiG-15
3	Supersonic speed; pulse radar; able to shoot at targets beyond visual range	"Century Series" fighters such as F-105; F-4; MiG-17; MiG-21
4	Pulse-Doppler radar; high maneuverability; look-down, shoot-down missiles	F-15, F-16, Mirage 2000, MiG-29
4+	High agility; sensor fusion; reduced signatures	Eurofighter Typhoon, Su-30, advanced versions of F-16 and F/A-18, Rafale
4++	Active electronically scanned arrays; continued reduced signatures or some "active" (waveform canceling) stealth; some super cruise	Su-35, F-15SG
5	All-aspect stealth with internal weapons, extreme agility, full-sensor fusion, integrated avionics, some or full super cruise	F-22, F-35
6 (potential)	Extreme stealth; efficient in all flight regimes (subsonic to multi-Mach); possible "morphing" capability; smart skins; highly networked; extremely sensitive sensors; optionally manned; directed energy weapons	–

Table 1: Fighter Aircraft by Generation[20]

Country	Generation 2	Generation 3	Generation 4	Future developments
Thailand	Alpha Jet, L-39ZA/ART	F-5E/F/T	F-16A/B, Gripen	F-16 upgrades and possible Su-30 buy
Malaysia	BAE Hawk 208	F-5E/F, RF-5E	F/A-18D, Mig-29N/UB, Su-30MKM	Su-30, Rafael, Typhoon, Gripen, Super Hornets to replace Mig-29[21]
Indonesia	EMB 314 Super Tucano, TA-50, Hawk 209,	F-5E/F	F-16A/B Blk 15, F-16C/D Blk 30s, Su-27, Su-30MK	50 KF-X, more Su-30MK2
Vietnam	Yak-130, MiG-21, Su-22	-	Su-27, Su-30	More Su-30s, low cost 4th Generation fighter to place Mig-21s
Singapore	-	F-5ST	F-16C/D Blk 52/+, F-15SG	Next Generation Fighter

Table 2: Regional Fighter Aircraft

Stealth technology is postulated to be a game changer for the fighter aircraft and the airpower landscape, verified by the USAF's experience of employing the F-117 stealth ground attack aircraft in Operation Iraqi Freedom as the first operational stealth aircraft used in combat. The US concluded that stealth did not change warfighting concepts fundamentally, but it enhanced the existing fighter roles tremendously.

The key to stealth is the ability to penetrate heavily defended radar networks and employ precision weapons on strategic targets. It gains the initiative because of the element of surprise, agility because the aircraft can afford to be proactive as opposed to reactive against threats, and depth because it allows high altitude ingress with impunity. Stealth is also more efficient because it requires less airborne support from escort and sweep fighters, midair refueling, and electronic warfare support from dedicated jammers. In one example from Desert Storm, eight non-stealth strike aircraft and 30 escort aircraft were required to strike one target, compared to 21 F-117 which took down 37 targets.[22]

Besides being a very effective tool for Offensive Counter Air (OCA, including strike and sweep missions) and Suppression of Enemy Air Defenses (SEAD), stealth technology can also be used effectively in Close Air Support (CAS) missions. It reduces the effectiveness of enemy air defense surveillance, fire control and target destruction—giving the stealth aircraft greater survivability. Stealth also grants fighters the advantage of first look and first kill in aerial warfare.

Despite stealth technology's immense potential, the non-stealth fighter aircraft will remain the primary choice of regional nations seeking to improve their airpower capabilities. This is because of the high costs associated with stealth technology and the relatively small defense budgets of countries in the region. Thus, only small numbers of stealth aircraft will be used hand-in-hand with a largely non-stealth fighter fleet.

Networks

Network or data link technology refers to the linking of fighters and other military assets by means of a high frequency, high-speed wireless connection. This technology was first introduced into the region through the Generation 4 fighter aircraft such as Thai Gripen's Tactical Information Data Link System (TIDLS) and the F-15SG's NATO-standard Link 16 data link system,[23] and will continue to be introduced through newer fighter aircraft.

Data link technology greatly enhances the fighter pilot's situational awareness: while he was previously limited by the power and capability of his own aircraft radar, he now sees the entire battle space picture stitched together from the radar returns of other airborne fighters, Airborne Warning And Control Systems (AWACS), and ground-based radars.

Data link information, however, is only as good as the fidelity of the radars contributing the 'donated' tracks. While AWACS and ground-based radars provide numerous data link tracks from their wide coverage radars, they merely provide cueing for the fighter radar. It is the fighter radar that provides the greatest accuracy for weapons employment.

Data link technology ultimately enhances the situational awareness and thus lethality of fighters, and will eventually become a baseline for all fighter aircraft in the region. Fighter aircraft which are not data link capable will fall well behind those that are, because they will have to rely on rudimentary voice communication and individual aircraft sensors to build situational awareness. Data link capable aircraft, on the other hand, have access to donated tracks which appear on their situational displays and have no need for single voice transmissions, giving them great situational awareness. It is likely that this stark difference would drive nations towards building a fully data link capable fighter force.

Electronic Warfare

Electronic Warfare (EW) can be split into Electronic Protection (EP), Electronic Support (ES) and Electronic Attack (EA).[24] ES systems detect and analyze electromagnetic emissions. Examples include Radar Warning Receivers (RWR) and Missile Warning Systems (MWS). EP systems refer to capabilities which increase aircraft survivability in a hostile environment, such as chaff and flare. ES and EP systems are currently widely available in the region's Generation 2 to 4 fighter aircraft, because they are a baseline requirement for enhancing fighter aircraft survivability in combat.

The most sensitive aspect of EW is EA, more commonly known as jamming, because of its offensive capability. From Generation 3 onwards, fighter aircraft have become heavily reliant on radar and data link technology, which are susceptible to jamming. Nevertheless, fighter aircraft can still function with degraded fighting capabilities—it will simply resemble a Generation 2 aircraft lacking these features.

In the region, EA technology is still in its nascency. The Thai Gripen C/Ds come with provisions for a Self-Protection Jammer (SPJ) pod.[25] The future Gripen NG boasts three internal jammers.[26] The F-35s may potentially come with the Next Generation Jammer (NGJ) that will complement the jamming capabilities of its Active Electronic Scanned Array (AESA) radar,[27] as power and agility of AESA beams also have the potential to be used for jamming purposes.[28]

Advanced Munitions

Munitions have evolved from "dumb" General Purpose (GP) bombs to Precision Guided Munitions (PGMs, guided by laser and/or GPS) used in Operation Iraqi Freedom, to Precision Stand-Off Weapons (PSOWs, boasting further ranges) such as the Small Diameter Bombs (SDB), and finally to even unique munitions such as the loiter-capable Delilah Missile.

There has been a worldwide increase in the popularity of SDBs because of the global trend towards asymmetric warfare. The events of 9/11 and its ensuing mayhem rudely awoke traditional armed forces that were trained for large-scale high intensity warfare to review their effectiveness against asymmetric threats. Asymmetric warfare is particularly unforgiving in terms of collateral damage, while demanding flexibility and time criticality in employment. SDBs, which are half the weight of previous "standard" 500lbs bombs, precisely fulfill these requirements. They allow a fighter aircraft to carry double the amount of weapons (thus more targets per sortie), with reduced collateral damage estimates due to smaller size and destructiveness. It fits into the internal carriages of stealth fighters like the F-35, and can be employed by UCAVs and potentially even ground launchers.

Thus far, the use of UAVs in the region has been restricted to Air Intelligence, Surveillance and Reconnaissance missions performed by light-weight UAVs, and this trend looks set to remain in the near future.

Air Forces in the region generally lag behind in this global trend toward advanced munitions. They primarily operate with GP or "dumb" bombs—what the Generation 2 to 4 fighters are capable of employing. The Generation 4 Fighters in the region are a notch above though, and are capable of employing PGMs such as F-15SG's Laser Joint Direct Attack Munitions (LJDAM) with appropriate upgrades. PSOWs are also likely to proliferate quickly among Generation 4+ fighters and beyond, because of the greater flexibility they offer.

Alternatives: UAVs

For years, Singapore has been a pioneer of UAV operations in the region, operating the Scout, Searcher II, Hermes 450 and Heron-1. Indonesia also operates the Searcher II, while other nations generally operate locally made UAVs.[29] Thus far, the use of UAVs in the region has been restricted to Air Intelligence, Surveillance and Reconnaissance (AISR)

missions performed by light-weight UAVs, and this trend looks set to remain in the near future. There have been no indications of larger and more capable UAVs or UCAVs entering the region due to political sensitivity.

Alternatives: Ground-Launched Strike Capabilities

Ground launched strike capabilities were introduced in the region when Thailand procured the ASTROS II Multiple Launch Rocket System (MLRS), and Malaysia purchased the same system soon after.[30] Thereafter, Singapore purchased the region's first ground launched precision strike capability—the GPS-guided M-142 HIMARS. Thailand is still modernizing her MLRS systems by developing the DTi-1G (Guided) which is said to have a range of up to 180km. If the region continues in this direction, these technologies will complement or eventually replace fighter aircraft for short-range strike missions (<100nm). As for ballistic or cruise missiles, it is highly unlikely that any nation in the region will procure them due to the dire political consequences of possessing such systems.

THE FUTURE TACTICAL BATTLE

"You feel the adrenaline rushing as the jet engine cranks up. Your large touch-screen glass displays light up, showing that the engine parameters are good. As the data link comes online, you receive updated mission orders that you have been re-roled to strike multiple terrorist cells inside Redland, who is supporting the terrorists. You acknowledge your orders with a touch of the screen.

Your electronic warfare, avionics and sensor suite goes through its BIT test and your helmet mounted display sight brightens up, revealing all critical flight parameters. The ground crew arms your mixed load of Small Diameter Bombs, GPS and laser-guided LJDAMS, and the chaff/flare suite. With all systems green and armed, you taxi out. You check your wingman's aircraft and see that all the bomb racks carrying various weapons are now retracted for take-off in your stealth jets. Before take-off, you have full situational awareness of the most up-to-date battlefield picture through data link tracks donated by airborne AWACs and fighters. Through the data link situational display you know that your blue forces are still fighting for air superiority. Few targets remain within 100nm as they have largely been taken out by the Guided-MLRS employed by the Blue Army. After a stream of artillery fire, you are cleared for takeoff.

Airborne, you track deep into Redland as you avoid the threat rings of numerous Surface-to-Air threats. Glancing at the data link situation display, you know that you will have to penetrate a set of threat rings, but as a stealth fighter, you are confident of success. With all sensors in passive mode, you and your wingman are as silent as the wind. Your electronic warfare suite shows that you are not being targeted by Red radars.

You receive an updated target photo from integrated Air ISR UAV and satellite sensors, and you realize that four of your twenty targets have shifted their location, while two are still on the move. The data link network automatically updates the target coordinates, while two forward launched UAVs track the two mobile targets.

Surrounding your targets are numerous surface to air threats, but you know that the range of your stand-off SDBs will keep you out of harm's way. Once within range of your targets, you and your wingman pickle off your SDBs, each assigned to a particular Desired Point of Impact (DPI). As the bombs come off the rack, your momentarily "dirty" (non-stealthy) configuration allows the enemy to detect you on his sensors and your Radar Warning Receiver (RWR) issues an immediate alert. You and your wingman immediately egress back to Blueland, deploying electronic countermeasures in the form of chaff, before quickly accelerating for supersonic cruise out of enemy territory. The RWR goes silent, showing that the enemy is no longer able to track you. At the same time, the Air ISR sources report the Battle Damage Analysis that all your targets have been successfully hit. Mission success.

On your way back, your data link reveals that Redland has launched a volley of retaliatory strike fighters towards your homeland and your air defenders require support from all airborne assets. Sure enough, you

receive mission orders to be re-roled for air defense but you are already prepared. You turn your sensors to active mode and your AESA radar immediately picks up the nearest airborne threats. One-by-one, the missiles come off the rail on multiple red strikers. Your data link shows that your wingman has also targeted the remaining few strikers with missiles. Your helmet mounted display cues you in on the positions of all the enemy fighters, and you verify the missile hits through small explosions in the distance, except for one target.

Your RWR lights up again with a missile launch warning, this time from the lone surviving fighter. On top of that, you see that your radar is now jammed by Redland. To survive, you jump into a notch maneuver (a 90-degree out turn). Your jammer automatically directs jamming against the surviving fighter and you notice that your RWR no longer lights up. You know that the jamming is effective but you decide to stay in the notch for improved survivability. Your wingman is out of missiles, but he supports you by providing a radar lock on the remaining fighter. Through your helmet mounted display, you pick a tally on the red fighter. You quickly cue your remaining high-off-boresight infrared missile to the fighter, and with a good tone and missile lock-on, you fire off your last missile. The lone fighter bursts into a ball of flames before he can employ further weapons against you."

CONCLUSION – THE SKIES AHEAD

As painted in the above scenario, fighter aircraft will still remain a formidable weapon of airpower worldwide in the days to come. Given the current trends in development, this predication should also hold true in the region. The cardinal requirement of SA and flexibility in air combat, and the continued developments in fighter-complementing technology such as stealth, data link technology, advanced munitions and electronic warfare, support the above notion. Although UAVs and alternative ground launched strike options will continue to be developed, they cannot effectively replace fighter aircraft in all its mission roles, except for several areas such as "dull, dirty and dangerous" missions, and close range strikes.

However, the escalating cost of fighter aircraft, as well as the utility of UAV and ground launched strike capabilities mean that fighter aircraft will not soar alone in the skies ahead. Instead, we will see integrated air operations between fighter aircraft, other manned aircraft, UAVs, ground launcher and even satellite-based sensors.[31] Data link makes this integration possible by providing a unified operational picture of the battlefield. This allows commanders to harness the strength of all their assets to maximize the projection of power or influence to achieve strategic, operational or tactical objectives, that is, airpower.

ENDNOTES

1. "Drone Strike Kills Senior Afghan Terrorist Linked To Kidnapping Of US Soldier," *The Washington Free Beacon*, 6 September 2013, http://freebeacon.com/drone-strike-kills-senior-afghan-terrorist-linked-to-kidnapping-of-us-soldier/.
2. *Defense Technical Information Center Annual Report: Unmanned Aerial Vehicles*, (Ft. Belvoir, VA: Defense Technical Information Center, 1995), 35.
3. This statement applies to some nations more than others, and depends largely on the political structure and the perceived threat of war to the nation.
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