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14. ABSTRACT

To deter China and counter current US numerical, geographic, and air-to-air missile deficiencies in the air domain, the US should immediately supplement its advanced fighter fleet with counterair MQ-9s and XQ-58s capable of firing BVRAAMs utilizing an offboard third party generated targeting solution. Cost effective RPAs armed with AIM-120s and future AIM-260s BVRAAMs would allow persistent operations from EABs within China's weapons engagement zone (WEZ) until air superiority is achieved and maintained all while reducing the loss of US lives and expensive manned aviation assets.

15. SUBJECT TERMS
PL-15; AIM-120; Counterair; Remotely Piloted Aircraft; RPAs; F-35; China; Expeditionary Advanced Base; EABs; MQ-9 Reaper; XQ-58 Valkyrie

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MASTER OF MILITARY STUDIES

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SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

Title: US Air Superiority in a Conflict with China: Requirements to Supplement Fifth Generation Assets with Counterair Remotely Piloted Aircraft

Author: Major Evan L. Osborn, United States Marine Corps

Thesis: To deter and win an aviation conflict with China, future Marine aviation needs to prioritize the mass proliferation of unsophisticated, remotely piloted aircraft (RPAs) armed with beyond visual range air-to-air missiles (BVRAAM) to supplement current fifth generation fighter technology.

Discussion: This paper shows why a current BVRAAM air-to-air missile mismatch and geographical location give China the upper hand in a battle for air superiority against the US in vicinity of the first and second island chains. Many of the points within this paper were validated during a recent Marine Corps Warfighting Lab Exercise ASSASSINS MACE. Regardless of the scenario that leads to a US-China conflict, this paper focuses on an air battle in vicinity of the second island chain outside of China's land-based missile engagement zone (MEZ) in an effort to limit external variables. This geographical location therefore limits China's combat power to aviation assets, facilitating a direct comparison to the US's deployed assets without allied contributions, a worst-case but realistic scenario. To counter this asset mismatch, the US must supplement its advanced fighter fleet with unmanned aircraft systems (UAS) capable of firing a BVRAAM utilizing an offboard generated targeting solution.

Conclusion: To deter China and counter current US deficiencies in the air domain, the US should immediately supplement its advanced fighter fleet with counterair MQ-9s and XQ-58s capable of firing BVRAAMs utilizing an offboard third party generated targeting solution. Cost effective RPAs armed with AIM-120s and future AIM-260s BVRAAMs would allow persistent operations from EABs within China's threat weapons engagement zone (WEZ) until air superiority is achieved and maintained all while reducing the loss of US lives and expensive manned aviation assets.

DISCLAIMER

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Preface

The US has maintained its position as a hegemon through power projection using our advanced weapons and capabilities as a strategic deterrent. The US can no longer rest on its laurels as nations such as China develop technology that is equal to or exceeds US capabilities. Victory against China must be won through deterrence and diplomacy. As a last resort, if the previous two fail, only then through military intervention. To succeed in both deterrence and conflict, the US must have superior technology to gain and maintain air superiority as part of a joint forcible entry capability against China in the vicinity of the first and second island chains. As the Marine Corps significantly changes its force design to counter China's influence in the Pacific, the US must maintain the upper hand in an air conflict. It is for these reasons that I have always been interested in what is required to roll back China's integrated air defense (IAD) and gain air superiority. As nations develop fifth generation fighters and even with the advent of six generation on the horizon, the adversary with the longest reach, largely a result of their air-to-air missile capabilities, has the advantage. The US cannot afford to lose this contest; the time to act is now.

I would like to thank Eric Y. Shibuya, PhD, LtCol Patrick Manson, and LtCol Zachariah "Butters" Anthony for the guidance and assistance throughout the development of this paper. Additionally, I appreciate the feedback received from the Marine Corps Warfighting Lab and for allowing me to participate in Exercise ASSASSINS MACE. This exercise allowed me to vet my assumptions regarding the outcome of China's aggressive actions towards Taiwan, therefore initiating the conditions for US intervention. Lastly, but most importantly, I would like to thank my family, particularly my wife, for taking on the additional responsibilities within the home while I was working on this project.

INTRODUCTION

If the United States went to war with China today, it could not establish and maintain air superiority with its current assets, proficiency, and force design. Over the last decade, China has significantly bolstered its military capabilities, evolving from a force with limited projection to a peer threat capable of exerting power throughout the Pacific. This rise in power to a peer competitor is a direct outcome of the funding devoted to the modernization and development of China's military as well as its expanding regional focus beyond the second island chain. Simultaneously, the United States has boosted its military in recent years with a significant portion of service budgets allocated to the development, procurement, and advancement of two types of fifth generation fixed wing aircraft – the F-22 and F-35. Though the US fleet of fifth generation aircraft represent the pinnacle of aviation technology, the development of China's indigenous fifth generation fighter, the J-20, and its sheer number of other assets armed with PL-15 (Pī Lì-15, Thunderbolt-15) beyond visual range air-to-air missiles (BVRAAM) has given China a significant advantage in achieving air superiority surrounding the Pacific. To deter and win a current aviation conflict with China, future Marine aviation needs to prioritize the mass proliferation of unsophisticated, inexpensive, remotely piloted aircraft (RPAs) armed with BVRAAMs to supplement current fifth generation fighter technology.

This paper will demonstrate how a current air-to-air missile mismatch and geographical location give China the upper hand in a battle for air superiority against the US in vicinity of the first and second island chains. In an effort to conduct a relative comparison of combat power and limit variables, this paper focuses on an air battle in vicinity of the second island chain outside of China's land-based missile engagement zone (MEZ). This geographical location, therefore, limits China's combat power to aviation assets, facilitating a direct comparison to US assets without allied contributions. This is a worst-case, but realistic initial scenario. This comparison also favors US access to nine airbases within the first and second island chains generating a best-case scenario for the US to marshal air assets within a conflict. To counter this asset mismatch, the US must supplement its advanced fighter fleet with unmanned aircraft systems (UAS) capable of firing a BVRAAM utilizing an offboard generated targeting solution. Cost effective remotely piloted aircraft (RPAs) armed with BVRAAMs such as the US Air Intercept Missile-120 (AIM-120D), an advanced medium-range air-to-air missile (AMRAAM), would allow persistent operations within China's weapons engagement zone (WEZ) all while reducing the loss of US lives and expensive manned aviation assets.

AIR SUPERIORITY

To deter or win a conventional conflict, gaining and maintaining air superiority is considered one of the most import factors required to facilitate friendly freedom of action. Without air superiority, friendly operations can be contested in any physical domain, significantly turning the tide of a conflict. As Field Marshal Bernard L. Montgomery so elegantly stated, "If we lose the war in the air, we lose the war and we lose it quickly."[1] Historically, air superiority is a critical requirement to facilitate the campaign plan designed by the Joint Force Commander (JFC). Joint Publication (JP) 3-01, *Countering Air and Missile Threats* defines air superiority as the "degree of control of the air by one force that permits the conduct of its operations at a given time and place without prohibitive interference from air and missile threats."[2] Air superiority, even if only temporary and localized, is an absolute requirement to prevent enemy air and missile threats from interfering with friendly air, land, maritime, and space operations, therefore enabling autonomy of maneuver for the JFC.

Air superiority provides freedom from attack, freedom to attack, freedom of action, freedom of access, and freedom of awareness. Importantly, it also precludes adversaries from exploiting similar advantages. As such, air superiority [in conjunction with cyber] underwrites the full spectrum of joint military operations and provides an asymmetric advantage to friendly forces. A lack of air superiority significantly increases the risk of joint force mission failure as well as the cost to achieve victory both in terms of resources and loss of life.[3]

In order to understand the complexity of the air domain it is necessary to define counterair operations and the aspects that it encompasses. Per JP 3-01, air superiority is achieved through "the counterair mission [which] integrates offensive and defensive operations to attain and maintain the joint force commander's desired degrees of control of the air and of protection by neutralizing or destroying enemy aircraft and missiles, both before and after launch."[4] The summation of air superiority (achieved through counterair) is the ability to conduct air operations free of prohibitive interference from the enemy force. This can only be achieved through active and defensive counterair actions.

To gain and maintain air superiority, the US must conduct effective and continuous offensive and defensive counterair operations. China has the upper hand when it comes to establishing air superiority predominantly due to the number of assets regionally available and the significant mismatch of the Chinese PL-15 BVRAAMs range in comparison to the US AIM-120. Only through offensive operations can the United States penetrate and exploit gaps within the Chinese Fighter Engagement Zone (FEZ).

A FEZ, whether in vicinity of the contested islands in the South China Sea or following military conflict between China and Taiwan, all require the US to defeat China's air assets. One of the most difficult and realistic scenarios that would result in a US - China conflict would be the defense of Taiwan per the Taiwan Relations Act. Should China attack/invade Taiwan, the US would be drawn into a conflict that is not geographically advantageous. Following a large missile barrage primarily targeting Taiwan's aerodromes and surface-to-air missile (SAM) sites, China would be able to establish a FEZ that extends roughly to the second island chain as a strategic deterrent and in preparation for US intervention. China establishing air superiority in vicinity of the second island chain would force the US to fight west, giving China the advantage. In addition to its FEZ, China has a significant MEZ covering Taiwan that extends just short of the first island chain. This layered defense allows China to combine its FEZ and MEZ to create a Joint Engagement Zone (JEZ) which extends from the mainland to approximately the first island chain all while utilizing defensive counterair to protect its forces.

(Figure 1) Depiction of China's JEZ and FEZ

Source: The Economist with Overlay Constructed by the Author

This layered defense allows China to combine both fighters and missiles to create an integrated defense that becomes more capable as China advances its ability to fully integrate and deconflict its assets. This scenario is a realistic approach following the rapid seizure of Taiwan, assuming that China will suffer relative few losses of air assets due to its large missile barrage utilized to disable the IADs and airfield infrastructure within Taiwan. These worst-case scenario assumptions allow for a direct comparison of combat power between China and the US focusing on an air battle in vicinity of the second island chain outside and independent of China's land-based MEZ. An air battle in this location is beyond China's SAM range, therefore isolating its combat power to aviation facilitating a direct comparison to US assets without allied contributions; a worst-case but potentially realistic scenario. Additionally, both China and US naval surface and subsurface counterair missiles would be a draw and are therefore not addressed within this comparison. To further understand the requirements to achieve contested air superiority, it is necessary to examine offensive and defensive counterair operations.

Offensive counterair (OCA) operations can be broken down into attack operations, suppression of enemy air defense (SEAD), fighter sweeps, and fighter escort.[5] Attack operations are conducted to destroy, disrupt, or degrade enemy counterair assets prior to launch either through kinetic or non-kinetic means. The intent is to target enemy assets such as surface-to-air missile sites, theater ballistic missiles (TBMs), airfields, infrastructure, and command and control in an effort to prevent their employment. Attack operations offensively target enemy assets to the left of launch thereby reducing the enemy's capability to impede friendly operations and create prohibitive interference.

In World War II during the first week of Operation BARBAROSSA, the Luftwaffe destroyed more than 4,000 Soviet aircraft with a majority on the ground therefore limiting Soviet air combat power. In the 1967 Arab Israeli War, the Israeli Air Force destroyed over 400 Arab aircraft on deck during the first two days, exploiting and creating a larger gap in enemy air operations.[6] If China invades Taiwan – as validated with the author's experience within the recent MCWL wargame Assassin's Mace – the Taiwan Air Force can be rendered combat ineffective with little to no attrition to China's aviation assets in an opening missile salvo. Taiwan's 288 fighter aircraft[7] will have little to no effect and China's counterair assets will remain relatively unimpeded to establish air superiority with the exception of SAMs and air defense artillery.

Offensive attack operations are extremely effective if friendly assets are able to gain and exploit access to enemy targets. However, due to the complexity of the JEZ surrounding China and the first island chain, the US must rely primarily on ballistic missiles and unmanned assets in an attempt to conduct attack operations and therefore degrade the total number of enemy assets. China has a robust JEZ and layered counter missile capabilities; therefore, attack operations will have little effect until US manned fifth generation fighters can access and exploit gaps in the outer protective FEZ. This access can only be achieved after an air battle is waged in vicinity of the second island chain facilitating access and the rollback of the enemy's JEZ and infrastructure. It is for this reason that the counterair fight within the first and second island chain is so vital should a deterrence fail.

This rollback of the enemy's JEZ will require a significant amount of SEAD missions after the outer FEZ is penetrated and reduced. When an active air defense is established, SEAD is used to neutralize, destroy, or degrade the enemy's surface-to-air assets (comprising China's MEZ) with the primary focus on high value targets such as radars that provide guidance or an operational picture for weapons systems employment. The destruction of surface-to-air threats and air defense artillery are a key component of achieving localized air superiority within an enemy's JEZ. Enemy assets destroyed on the ground during attack operations and SEAD operations limit what the enemy can bring to bear on friendly forces, thereby reducing the numerical requirements for future fighter escorts and sweeps.

China's JEZ is limited by the range of their land-based sites or the effective range of its missiles. China's FEZ extends well beyond that to the second island chain, thereby creating a requirement for the US to destroy China's outer FEZ prior to the JEZ rollback around the first island chain. Until control of the air domain is established and the JEZ reduced, fighter escorts are required to provide dedicated protection in an air-to-air capacity in support of other air missions or in a defensive counterair (DCA) role to protect high-value airborne and surface assets. As air superiority is achieved, the requirement, and total number of friendly assets essential to conduct fighter escort is significantly reduced.

The design of China's IADs with a layered engagement zone will require a significant fighter sweep. This fighter sweep is one of the most important factors and the primary focus of this paper in an effort to roll back the Chinese FEZ around the second island chain, access the JEZ in vicinity of the first island chain, and establish overall air superiority within the conflict. A fighter sweep is an offensive mission conducted by fighter and interceptor aircraft configured in an air-to-air role to locate and destroy enemy airborne aircraft in a designated area[8]. Fighter sweeps are absolutely necessary in order to establish and maintain local air superiority. During the initial stages of this conflict, the JFC needs to prioritize fighter sweep missions over attack operations until the outer FEZ is destroyed in vicinity of the second island chain. If fighter sweeps are not prioritized, then attack operations are vulnerable to enemy air in locations where localized air superiority is contested. Once the outer FEZ is destroyed, the JFC can allocate sorties between fighter sweeps and attack operations depending on the current threat within the remaining JEZ surrounding the first island chain. Eliminating the outer FEZ protected by China's fifth generation fighter/interceptor aircraft armed with PL-15 BVRAAMs is the first and extremely difficult step to gain air superiority within theater.

DCA operations are broken into two categories: active air and missile defense (AMD) and passive air and missile defense. AMD are the defensive actions taken to "destroy, nullify, or reduce the effectiveness of hostile air and ballistic missile threats against friendly forces and assets. It includes actions to counter enemy manned and unmanned aircraft, aerodynamic missiles (cruise, air-to-surface, & air-to-air), and ballistic missiles."[9] This can be accomplished through a variety of means, either using kinetic fires or electronic attack that create a defense in depth. Active AMD is one of the key components for gaining and maintaining air superiority. The US must conduct sound DCA operations to protect US assets and facilitate offensive counterair holistically contributing to local and theater air superiority. In addition to active air defense, the US must also conduct passive air defense measures.

Passive DCA measures are means to reduce the effectiveness of the enemy's air and missile threats through the employment of non-kinetic, other than active means. Examples of passive AMD include detection and warning, camouflage, concealment, deception, dispersion, redundancy, mobility, and hardening to name a few[10]. Passive DCA is essential in a conflict against China as it is these measures that will protect assets within theater, expeditionary advance bases (EABs), and naval forces all while the JFC concentrates forces to counter China's hold on air superiority. Passive DCA is extremely important for the survivability of the aircraft bed down locations and EABs as the US fights west to gain a foothold and conduct joint forcible entry operations (JFEO).

COUNTERAIR ASSET COMPARISON

Within the first and second island chain, China has the upper hand when it comes to establishing air superiority predominantly due to the current mismatch of the Chinese PL-15 BVRAAMs in comparison to the US AIM-120 and number of assets regionally available. Not only is China increasing the total number of fixed wing aviation assets in both the People's Liberation Army Air Force (PLAAF) and the People's Liberation Army Navy (PLAN), they are also modernizing the fleet from second and third generation to predominately fourth and fifth generation aircraft.[11] This strategic realignment is a stated priority within China's 2015 Military Strategy:

> In line with the strategic requirement of building air-space capabilities and conducting offensive and defensive operations, the PLA Air Force (PLAAF) will endeavor to shift its focus from territorial air defense to both defense and offense and build an airspace defense force structure that can meet the requirements of informatized operations. The PLAAF will boost its capabilities for strategic early warning, air strike, air and missile defense, information countermeasures, airborne operations, strategic projection, and comprehensive support.[12]

Over the last decade, China has rapidly bolstered their military in terms of numerical assets, spending, and modernization; particularly in regards to air power.

In 2019, China increased its annual military budget by 6.2 percent, maintaining its status as the second-largest military spender only behind the US. Of note, China's published budget omits several key categories of expenditures, therefore underscoring the actual military funding allotted which may be significantly larger than published.[13] With the increase in spending, China's priorities for military spending have remained focused on modernizing its fleet and the advanced development of weapons systems to facilitate long-range power projection. The aim of China's power projection is to serve as a strategic deterrent for US intervention surrounding the first and second island chain. "In 2017, Lieutenant General Ding Laihang assumed the post of PLAAF commander and exhorted the service to build a truly "strategic" air force capable of projecting airpower at a long range."[14] The 2020 DoD annual report to Congress states that the West's advantage in the air environment in comparison to China has significantly decreased. "This trend is gradually eroding longstanding and significant U.S. military technical advantages vis-à-vis the PRC in the air domain."[15] The increase and modernization of the PLAAF and the PLAN is reflected in their internal aircraft development and external procurement.

The PLAAF and PLAN combined constitute one of the largest aviation forces within the region and overall, the third largest in the world. China currently has over 2,500 total tactical aircraft of which 2,000 are fighters, interceptors, bombers and attack aircraft – not counting training aircraft or remotely piloted aircraft (RPAs). China's current aircraft inventory is extremely capable and as the total number shows, extremely well suited to counter US and allied attempts at establishing air superiority in a reactive conflict.

It is difficult to precisely determine the total number of PLAAF and PLAN counterair fighter and interceptor aircraft as China is not forthcoming with its total number of combat capable aircraft. Additionally, China's total readiness in terms of the percent of partially or fully mission capable aircraft is unknown, but assessed to be similar or slightly less than that of the US, generally between 60-70% at best. As a result, when generating a total combat comparison between China and the US, the numbers utilized are averaged from multiple sources indicated in tables 1 and 2. Based on figures derived from RAND's 2017 assessment[16] as well as the 2021 World Air Forces Directory[17] presented in Table 1, the total number of counterair fighter/interceptor assets China is assessed to have is between 1,396 and 1,463 depending on the source, averaging to 1,429 total counterair assets. Of the total assets capable of preforming in a counterair role, it is assessed that 911 are capable of employing the PL-15. This total number was determined based on the capability of the J-10C, J-11B, J-16 and the J-20 to employ the PL-15. These numbers presented are independent of a full mission capable, partially mission capable, or not mission capable (aircraft is down for maintenance) assessment.

When assessing the total US counterair fixed wing inventory presented in Table 2, the US has between 2,152 and 2,264 assets averaging to 2,208 total counterair assets. As with China's comparison above, the numbers presented are independent of a fully mission capable, partially mission capable, or not mission capable assets.

(Table 1) China's PLAAF & PLAN Fixed Wing Fighter/Interceptor Assets

Aircraft	Origin	Type	Variant	Total[18] (RAND) 2017	Total[19] (WAF) 2020	PL-15 capable (RAND)
3rd Generation						
Xian JH-7	China	Fighter/Bomber	JH-A/B	450	69	
Chengdu J-7	China	Fighter	J-7MG		418	
Shenyang J-8	China	Interceptor	J-8IIM	100	143	
4th Generation						
Chengdu J-10	China	Multirole	J-10B/C	340	260	X
Shenyang J-11/Su-27	China	Fighter	J-11B/D	400	354	X
Shenyang J-16	China	Fighter		121		X
Sukhoi Su-30	Russia	Fighter	Su-30MKK	-	76	
Sukhoi Su-35	Russia	Fighter	Su-35S	-	24	
5th Generation						
Chengdu J-20	China	Fighter/Stealth		50[20]	50[21]	X
Shenyang J-31	China	Fighter/Stealth		2[22]	2[23]	
Total Numbers						
				1,463	**1,396**	**911**
Source: Constructed by Author						

(Table 2) United States USAF, USN & USMC Fixed Wing Fighter/Interceptor Assets						
Aircraft	Origin	Type	Variant	Total[24] (Heritage and WAF)	Total[25] (WAF) 2020	AIM-120 capable
4th Generation						
F-15	US	Fighter	F-15C/D/E/X	452	429	X
F-16	US	Fighter	F-16C	783	789	X
F/A-18	US	Fighter/Attack	F/A-18A/C/D	(144)	144	
4.5 Generation						
F/A-18	US	Fighter	F/A-18E/F	(416)	416	X
5th Generation						
F-22	US	Fighter/Stealth		186	178	X
F-35	US	Fighter/Stealth	F-35A/B/C	283	196	X
Total Numbers						
				2,264	**2,152**	**2,264**
Source: Constructed by Author						

In a direct comparison of counterair assets to China, the US has significantly more assets, a difference of 779 more counterair fighter/interceptor aircraft. Additionally, China's counterair assets cannot all employ the PL-15 (only 911 can do so) whereas all US counterair assets in the inventory can employ the AIM-120D. When examining a direct numerical comparison, it appears that the US has the advantage; however, this is not reflective of a deployed force attempting to mass aviation combat power in vicinity of Taiwan for a limited duration. mission capable, or not mission capable assessment.

GEOGRAPHIC ASSESSMENT

A conflict in vicinity of Taiwan lends the geographic advantage to China. According to RAND, a "basing mismatch would enable a large portion of China's increasingly modern strike and fighter force to reach the battle area and put US fighter aircraft at a substantial numerical disadvantage."[26] China would have the geographical advantage in this conflict due to the 40 major airbases suitable for operations to project counterair sorties in vicinity of Taiwan without requiring tanker support. The US has two major (permanent) bases facilitating operations within 800 km of Taiwan. The total number of US military bases to facilitate operations can increase to nine per Table 3 if the US accepts operating within range of China's long range ballistic missiles and receives approval from Japan and South Korea to have combat sorties originate and terminate from airbases within their sovereign borders. Additionally, of these nine air capable bases – depending on the aircraft configuration and mission – seven would likely require significant tanker support to facilitate sorties to the contested airspace. These airbases are also limited in ramp, hangar, ammunition supply points, and maintenance space to safely and logistically accommodate US aircraft.

(Table 3) Air Capable Installation Distances

Air Capable US Installations	Distance to Taiwan	Distance to 2nd Island Chain (Bonin Islands)
Marine Corps Air Station Futenma (USMC) Okinawa, Japan	741 km	1,428 km
Kadena Air Base (Air Force) Okinawa, Japan	746 km	1,770 km
Kunsan Air Base (Air Force) South Korea	1,461 km	1,770 km
Marine Corps Air Station Iwakuni (USMC) Japan	1,594 km	1,238 km
Osan Air Base (Air Force) South Korea	1,597 km	1,808 km
Naval Air Facility Atsugi (Navy) Japan	2,183 km	978 km
Yokota Air Base (Air Force) Japan	2,215 km	1,009 km
Misawa Air Base (Air Force) Japan	2,681 km	1,526 km
Andersen Air Force Base (Air Force) Guam	2,756 km	1,515 km
Source: Constructed by Author		

Due to the limited air capable facilities within range of a contested air environment to mass combat power, the US will have to fit additional fixed wing assets on current airbases.

> [By increasing] additional fighters onto US bases where fighter wings are now located (Andersen AFB, Kadena AB, and Misawa AB) and station additional squadrons on other US air facilities (e.g., Yokota AB and the two MCASs in Japan), the total upper limit might conceivably be raised to six wings of ground-based fighters plus tanker support.

> With allowance for an additional 72 US Navy fighters more than the equivalent of a single US Air Force fighter wing) on board two aircraft carriers, the United States might, depending on circumstances, be able to maintain between 4.5 and seven fighter wings within range of Taiwan [and the first and second island chains].[27]

Utilizing RAND's analysis of basing counterair and support aircraft at air capable locations to the max compacity, this equates to a total of 72 aircraft per wing with approximately 50 of those aircraft being counterair capable. The US would only deploy full and some partial mission capable aircraft so assuming 7 total wings (joint assets owned by the JFC) with approximately 50 counterair aircraft, the Joint Force Air Component Commander would have approximately 350 total counterair assets to commit. Of the 350 aircraft, an extremely high readiness rate of 90% would equate to 315 combat capable counterair US aircraft.

China would have all of its assets, but a significantly lower fleet readiness rate, due to the fact it is geographically operating from home only requiring repositioning between theaters. However, with an assessed readiness rate of 60%, China's has a total of 857 combat capable assets, with 546 counterair assets armed and capable of employing the PL-15. This equates to 315 US counterair assets to China's 546 counterair assets capable of employing BVRAAMs. The advantage is clearly in China's favor both in quantity and BVRAAM capability.

In order for the US to mass seven fighter wings at the available locations, commanders would have to accept significant risk from China's ballistic missiles due to the poor passive AMD measures such as the lack of dispersion, deception, and hardened facilities. In an effort to mitigate some of these concerns as well as reduce the significant requirement of airborne tanker assets to support counterair and anti-submarine assets, the US would need to rely on expeditionary advanced base operations (EABO). These EABs would allow the US to operate forward within the enemy's FEZ at preestablished locations to refuel and rearm. Aircraft would only touch down at preexisting airfields forward arming and refueling points (FARPs) for a limited duration enroute to refuel and rearm. These FARPs require a preexisting/established long length runway capable of aviation operations for counterair assets. These assets would be rearmed and refueled by small teams rapidly to not only beat the targeting cycle of China, but to also create a target that is relatively low payoff not worth China expending its limited inventory of long-range ballistic missiles. Only by creating a low payoff target through limiting transient fighter aircraft to low numbers as well as duration on deck can US assets persistently operate from and capitalize on EABs. The use of EABs would increase combat radius and ordnance availability, all while reducing the requirements for high payoff targets such as airborne refueling tankers.

BVRAAM COMPARISON

China has the advantage in regards to numerical assets regionally capable of employment in a conflict geographically located between Taiwan and the second island chain. Further, in comparison to the US's AIM-120, China has a superior BVRAAM capable of employment utilizing third party data cueing. The country with the best missiles has the advantage in aerial combat, and in this case the advantage belongs to China.

> With the research and development of integrated, netted sensors, no longer is the fighter pilot limited by what he has on board as a primary or secondary sensor. His targeting range, aided by many combinations of contributors, is approaching over the horizon. Air-to-air missile deployment will no longer be limited to on-board sensor detection and tracking capabilities but by the maximum performance of the air-to-air missile. [28]

China's PL-15 BVRAAM is one of the most advanced BVRAAMs developed by the 607 Institute. The PL-15 is a significant upgrade of the PL-12; utilizing a modified and upgraded tail control assembly as well as smaller fins to allow it to fit internally within the J-20's internal weapons bay (a total of four missiles) facilitating the J-20 low observable signature. The most significant upgrade of the PL-15 is the dual pulsed solid state rocket motor capable of a maximum speed of Mach 4[29] allowing the missile to engage and destroy targets at standoff ranges up to 300-400 km.[30] The speed and range of the PL-15 missile create a no escape zone (NEZ) – the area in front of the launching aircraft where the bandit/enemy aircraft can be successfully engaged regardless of the maneuver it attempts – that is much larger than the US AIM-120 generating a higher probability of kill (Pk). In addition to the large range, the PL-15 utilizes a two-way data link that allows for inflight dynamic re-targeting from the original shooter or from solutions generated by offboard remote sensors. The missiles active electronically scanned array (AESA) seeker has a narrow target acquisition beam generating an exceptional electronic counter-countermeasures (ECCM) capability[31]. Though there are a variety of unclassified ranges associated with China's PL-15 missile, analysts agree that China's BVRAAM can significantly outrange and outperform the best US long-range air-to-air missile.[32] The total procurement inventory of the PL-15 is unknown as China is already working on its potential successor the PL-21.

The AIM-120D is the US's long range BVRAAM. The AIM-120 has been the only US long-range air-to-air missile since the early 1990s. The US has incorporated advanced hardware and software system upgrades throughout the years both in terms of technological performance to increase range and the engagement envelop all while maintaining its form fit size. The size of the AIM-120 is critical to allow an internal carry within the weapons bays of both the F-22 (a total of six) and F-35 (a total of four) preserving their low observable signature. The current variant, the AIM-120D is propelled by a dual pulse solid state rocket motor that is shipboard compatible, hazards of electromagnetic radiation to ordnance safe allowing an unclassified range of between 150-180 km.[33] A shortfall of the solid-state propellant motor is the limited distance and short burn time creating a significant energy bleed in the glide phase, allowing enemy aircraft to out maneuver and outrun the missile at medium ranges, thus generating a smaller NEZ than the PL-15. In terms of guidance, the AIM-120 uses an advanced RF seeker that is ECCM resistant, a bi-directional data link allowing diverse targeting inputs, and a High-Angle Off-Boresight capability. This allows the pilot to engage multiple enemy aircraft on either an on-board or off-board generated solution with the active radar guiding it to the target allowing the employing aircraft to defend/preform evasive maneuvers post launch. [34] The US Air Force and Navy received 1,031 AIM-120D missiles in 2014 completing their initial purchase."[35] Little unclassified information is known about the successor to the AIM-120D, the AIM-260 other than the fact that it is being developed to directly counter China's PL-15 both in terms of range and performance.

Comparing unclassified open-source information on China's PL-15 to the US's AIM-120D BVRAAM shows the gap in US long-range air-to-air capabilities. China's PL-15 has a greater launch success zone and larger NEZ, therefore generating a higher probability of kill (Pk). The US has been too reliant on its technological advantage over the last 30 years so that the development of China's PL-15 and J-20 has found the US military ill prepared to fight an air conflict in China's backyard. This is the first time that the US technological advantage in the air superiority realm has been truly challenged since World War II.

> [Former USAF Air Combat Commander and Pacific Air Forces Commanding General Herbert 'Hawk' Carlisle] cited the PL-15 as the reason for Congress to fund a new missile to replace the American AMRAAM. His reason for concern is [that] the PL-15…would out-range existing American air-to-air missiles, making the PL-15 not just a threat to fighters like the F-35, but also to US bombers and aerial tankers critical to American air operations across the vast Pacific. General Carlisle called "out-sticking" the PL-15 a high priority for the USAF.[36]

China has the US beat both in terms of geographically available assets and the range and capability of BVRAAMs when operating in vicinity of the second island chain all the way to Taiwan. According to RAND's 2017 combat modeling of an air conflict, China "had achieved parity with the U.S. in air superiority for any conflict close to its mainland, including over Taiwan."[37] As the US prioritizes the development of its next generation of BVRAAMs – the AIM-260 – so does China with the PL-21. The US needs to utilize RPAs armed with BVRAAMs to supplement current manned fixed winged aircraft. The use of RPAs such as the MQ-9 Reaper and the XQ-58A Valkyrie with a medium/long-range air-to-air capability would allow the US military to operate within China's threat ring utilizing low cost and risk-worthy assets all while increasing the lethality of US aviation.

RECOMMENDATIONS – COUNTERAIR RPAS

The 2019 Commandant's Planning Guidance specifies that the Marine Corps must focus on developing and proliferating "low signature, affordable, and risk-worthy platforms and payloads."[38] These platforms can be pre-stagged in a single shipping container[39] at strategic locations with 3,000-foot runways. When China crosses a specific threshold, the aircraft can be unpacked, assembled, and employed using a minimal launch and recovery crew on EABs and flown from CONUS. With a small footprint, a counterair variant of the MQ-9A Reaper could range approximately 1,000 nautical miles, an operating altitude of 50,000 ft, cruise at 200 knots, with an endurance of between 23-30 hours depending on the armament configuration on the six hardpoints. The newest MQ-9B could range 6,000 nautical miles, 40 hours or endurance with nine hardpoints and carry 4,000 pounds of ordnance.

The legacy MQ-9A has six hard points, three on each wing. Four of the six could be modified to accommodate LAU-127 launchers to employ AIM-120Ds. The total weight for a LAU-127 (87 pounds)[40] and the AIM-120D (335 pounds)[41] is 422 pounds, less than current hardpoint rating capability of 1500 and 600 pounds for the inner two points on each wing. The MQ-9B would only increase this capability with more hardpoints and a greater hardpoint weight capacity. With minimal modification to the MQ-9, the LAU-127 would allow an AIM-120 to be employed utilizing an offboard targeting solution provided through a datalink such as Link-16. This solution could be provided from a variety of airborne, ground, and naval stand-off sensors providing extremely accurate targeting data all while allowing the sensing asset to maintain a safe distance from the threat aircraft. An MQ-9 armed with AIM-120 BVRAAMs operating in a combat air patrol (CAP) capacity would allow the aircraft to remain airborne in a specific location for up to 12 hours or longer where as a manned fighter would require refueling almost every hour with a significantly higher operating cost. Though not stealth, a counterair variant of MQ-9s armed with AIM-120 BVRAAMs would provide a low-cost, low signature, unmanned aircraft able to operate from forward locations and assist in gaining US air superiority.

The ability of the MQ-9 to employ short range air-to-air missiles has recently been proven through multiple successful AIM-9X Sidewinder infrared missile engagement. The most recent test conducted in September 2020, the US Air Force demonstrated that MQ-9 could be utilized in a counterair role employing a short-range air-to-air missile from offboard target cueing provided through a datalink.[42] This successful test proves that not only can the MQ-9 receive offboard curing, but that the common launch adapter unit used for the AIM-9 and AIM-120 can mount and properly interface with the RPA and missiles.

The endurance, range, and payload of the MQ-9 provide a capability at a fraction of the cost in caparison to manned counterair assets. The F-22 costs around $70,000 per flight hour, the F-35 costs around $44,000[43], the F-15 costs around $40,000, and the F-16 is around $23,000, whereas the cost of the MQ-9 is $3,624.29 per flight hour.[44] The cost of the whole unmanned aircraft system, which includes four aircraft, sensors, and ground control station is 64.2 million dollars, or 16.05 million dollars per aircraft.[45] The US Air Force recently reduced the total number of MQ-9s being purchased to 337 with the final airframes being delivered between 2023 and 2024.[46] This is a significant number of assets that can be used to turn the tide in a counterair fight. The USMC recently purchased two MQ-9As for 26.9 million dollars, or 13.4 million per aircraft.[47] The MQ-9 is significantly cheaper to operate in comparison to any manned conventional counterair asset. Not only does this provide a capability at a significantly reduced cost, there is a decreased logistical requirement for in theater employment with basic launch, recovery, and maintenance crews. After launch, the aircraft is flown from sites within CONUS significantly reducing the footprint, logistical support and bandwidth required from remote locations both outside and within the second island chain. The employment of the MQ-9 in a counterair role provides an increased airborne magazine of BVRAAMs with unmatched on station time. These airborne missile carriers extend the lethality of manned assets through third party data-cueing effectively allowing near persistent unmanned CAPs capable of operating forward within China's FEZ with minimal cost and risk to friendly personnel.

Another RPA asset with increased range and capability in comparison to the MQ-9 currently in development is the Kratos XQ-58 Valkyrie. The XQ-58 is an affordable unmanned aerial system designed to work in conjunction with manned fighter and attack aircraft.[48] The XQ-58 uses off-the-shelf, rapidly developed, low-cost technology to produce a capable low risk RPA. The XQ-58 has a speed of 0.85 Mach, and maximum altitude of 45,000 feet, a range of 3,000 miles and ordnance payload up to 500 lbs. The RPA is designed to operate from EABs, taking off from a shipping container with a rocket-assisted launch and recovered with a parachute therefore not requiring a prepared runway. The US Air Force is developing the XQ-58 to operate as a "faithful wingman" in a strike and attack capacity, allowing manned fighters to control and employ the RPA while remaining outside the engagement envelope of enemy weapons.

Much like the MQ-9, the US should prioritize development of a counterair variant of the XQ-58 that can launch from EABs, establish as a CAP or a fighter sweep well forward within China's FEZ to engage enemy fighters/interceptors facilitating the rollback of China's fighter defense. Unlike the MQ-9 which relies on beyond line-of-sight space vehicles for communication with an inherent latency that is also susceptible to jamming, the XQ-58 can operate utilizing line-of-sight technology decreasing the susceptibility to meaconing, intrusion, jamming, and interference allowing almost real time inputs. Though these aircraft are not as survivable in comparison to manned assets with aircraft survivability equipment, their low cost in comparison allows for the mass production and use of existing assets to overwhelm China's counterair missile arsenal. Additionally, their cost and size would allow persistent operations by US stand-in forces within China's FEZ from EABs or pairing with the future Marine Littoral Regiment concept – which is beyond the scope of this paper.

CONCLUSION

There are many analysts that believe the US is over-estimating China's capabilities in terms of its ability to link ground, maritime, and aerial assets to create a combined defense out to the second island chain. What they do agree on, though, is that China is rapidly advancing its technology and military capabilities so if not now, then very soon China will be able to establish a joint defense integrating a variety of assets. This will create a "wicked problem" for the US in regards to gaining and maintaining air superiority. "When, as opposed to if, China can link its ground-based, maritime and aerial assets at a technical and operational level, it will be a formidable challenge for even the US Air Force and US Navy, able to contest airspace over 1,000 km from the mainland."[49] As the Marine Corps has adopted its new force design, the US DoD as a whole must prepare for the worst case, but realistic scenario of rolling back China's IADs to gain and maintain air superiority.

China clearly has the upper hand when fighting an air conflict in vicinity of Taiwan through the second island chain based on the numerical mismatch, its superior BVRAAMs, and home turf advantage. To deter China and counter US deficiencies in the air domain, the US should immediately supplement its advanced fighter fleet with counterair MQ-9s and XQ-58s capable of firing BVRAAMs utilizing an offboard third party generated targeting solution. The technology and assets already exist within the US inventory. The only requirements for employment are minor innovations to pair the assets, and the development of training and operational implementation. In conclusion, cost effective RPAs armed with AIM-120s and future AIM-260s BVRAAMs would allow persistent operations from EABs within China's WEZ. This would allow the US to deter or gain and maintain air superiority in a conflict while reducing the loss of US lives and expensive manned aviation assets.

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