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Preface and Acknowledgements

While I was flying with the Spanish Navy on an exchange tour in 2013, the initial rotation of SPMAGTF Marines arrived in Moron, Spain. I made it a goal to meet with as many of the Marines stationed there as an ambassador of sorts while they were in the Andalucian wilds, and to rekindle relationships with fellow United States Marines. Discussions of mission planning ensued, and a dilemma presented itself during these conversations: how to best escort the MV-22B *Osprey* aircraft over the long distances presented in the area of operations and responsibility. Nearly everybody I talked to understood the vulnerabilities of missions covering such distances, vulnerabilities that reared their head in South Sudan in December of that year. This work has been an attempt to present an option for protection of these highly-capable but vulnerable aircraft in situations like the ones faced on a daily basis today.

The list of people I must thank grows even as I write this preface, but above all I would be remiss to not thank my wife Julia for her dedication, patience, and frankly astounding abilities to juggle the desires of our children and her own life with my seemingly endless time with research, studying, and work during this past year.

My mentor Dr. Paul Gelpi was there when I had what most would consider a crisis during the development of my thesis. He has the ability to let students travel the road towards their Masters with copious amounts of patience and understanding.

The Marines I must thank are frankly some of the best, brightest, and most dedicated to their service as any that I have had the pleasure to serve with. LtCol Jim Lively and Captains Owen Sisbarro and Travis “SHAK” Barksdale were instrumental in helping me wrap my head around the “new normal” and operations conducted with the SPMAGTF. MV-22 pilots Majors Trong “Charlie” Do, Eric “Chewy” Keith, and Don “Lenny” Ransom have shown me that the *Osprey* is not nearly as terrifying as my previous experiences while nighttime refueling with them led me to believe. Finally, and certainly not least were Harrier pilots Majors Brett “Nilla” McGregor, Dan “Fister” Fiust, Mike “Spam” Cassidy, Ben “Clam” Beard, and Ryan “Puddy” Hough, who have all directly or indirectly reminded me how much I miss the Harrier community and what our beloved jump jet brings to the fight. I am truly looking forward to returning to the salt mines to work with all of them.

Finally, the airmen I have worked with from our sister service in blue have been some of the most helpful of the bunch. Mark Svetska, Mark Harysch, and Major Richard “Mac” McElhaney have all been instrumental in showing me that the C-17 *Globemaster III* is one of the biggest and most instrumental gears in the cog. Their planning efforts and assistance in putting me in touch with those in the know has been instrumental in my research and efforts. I am grateful for their ability to put service rivalries aside and help a knuckle-dragging attack pilot.

Executive Summary

Title: Long-Range Airborne Forward Arming and Refueling Operations

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Thesis: The Marine Corps must incorporate emerging forward arming and refueling concepts to present-day platforms in order to fully enable long-range aviation operations in support of Special Purpose Marine Air/Ground Task Forces deployed in support of “New Normal” operations.

Discussion: A capability gap exists with the present employment of Special Purpose Marine Air/Ground Task Force (SPMAGTF) long-range operations. Operations in the “New Normal” require disbursed and distributed operations, often long distances from home bases. Additionally, due to global sourcing requirements for the Marine Corps’ only organic tanker aircraft, the KC-130J, long-range missions flown by MV-22B aircraft will be essentially unescorted, potentially leaving the assault aircraft vulnerable in the landing zone. Emerging concepts by both the Marine Corps and Air Force account for distributed operations; Distributed Short Takeoff/Vertical Landing Operations (DSO) is the Marine contribution, and Rapid Raptor is the contribution of the United States Air Force. DSO, while a capable concept in its own right, requires assets beyond the SPMAGTF tables of organization and cannot be applied to fill the gap. Rapid Raptor, in conjunction with Marine AV-8B Harrier aircraft, can be applied immediately and with minimal training beforehand to provide escort, close air support, or landing zone operation support to MV-22B operations. In conjunction with forward arming and refueling operations developed with the support of MAWTS-1, Air Force C-17s can provide the joint force or component commander options for long-range missions with minimal to no external support from established aviation agencies.

Conclusion: The development of tactics, techniques, and procedures for forward arming and refueling (FARP) operations between Marine and Air Force aviation assets, specifically the AV-8B *Harrier* and C-17 *Globemaster III* airframes, should begin in earnest. The capabilities inherent in each aircraft are well-suited for small, distributed operations in austere locations, and can support missions far from the typical home base or airfield.

Background

Marine Corps operations in what has been coined the “New Normal” have been underway for just over two years.¹ Operations that, while initially intended to be quick-response “stopgap” measures, appear to be enduring. These operations hinge on the Special Purpose Marine Air/Ground Task Force, or SPMAGTF, a tailor-made force designed to be cobbled together with modular pieces from each portion of the Marine Corps, including ground, air, and logistics forces. SPMAGTFs contain detachments from Marine KC-130J and MV-22B squadrons with typically four and ten aircraft, respectively, but their focus is on the MV-22B and its capabilities. With an ability to fly at speeds approaching 300 miles per hour, and a range of close to 1,000 nautical miles, the *Osprey* is undoubtedly one of the most capable assault support aircraft in the world.² SPMAGTF forces currently deployed focus on two main areas: Africa and the Middle East, named SPMAGTF Crisis Response-Africa and SPMAGTF Crisis Response-Central Command, respectively. Created after the attacks on the American Embassy in Benghazi, Libya, these units deployed with the intention of having forces available on extremely short notice within their areas of responsibility. Such short notice is essential, as globally these two areas have had a plethora of recent attacks, insurrections, or full-blown insurgencies occur with minimal warning. However, with little to no warning, the inherent requirement for flexible, capable, and above all survivable platforms to deliver much-needed Marines delivering aid, firepower, or rescue capabilities is paramount. Marine aircraft arriving unprepared and without an ability to protect themselves in every regime of flight can cause small rescue missions to become catastrophic disasters.

Introduction

In late 2013, the deteriorating situation in South Sudan took a precipitous turn for the worse. Juba, the capital city, saw major fighting between factions of the South Sudanese military, and hundreds had been killed. As a result, the United States withdrew non-essential diplomats from its embassy on 16 December.³ Later that week, a rescue mission was launched from Camp Lemonnier in Djibouti to withdraw American relief workers located fifty miles from Juba in the city of Bor. The package was composed of three US Air Force Special Operations Command (AFSOC) CV-22 *Ospreys*, flown by pilots of the 8th Special Operations Squadron. Onboard also were US Navy SEALs, composing the ground rescue force. After a UN helicopter was shot down in the same area the day prior, the workers needed to be rescued, and quickly.⁴ These special operation forces were the best answer to a rapidly changing problem, and they launched to accomplish what appeared to be a fairly benign mission.

At 0600 on 21 December, the *Ospreys* conducted a single airborne refueling on a 900 nautical mile mission route, and descended into Bor to conduct an overhead pass of the compound. Upon confirmation of their landing zone, the lead aircraft, callsign Rooster 73, began to convert into helicopter mode when the flight of three began to take concentrated small-arms fire from the ground below. The crews had been told they were flying into a “permissive environment,” which was one of the reasons the *Osprey*, with only a single .50-caliber heavy machine gun, was considered appropriate for the mission.⁵ Yet after abandoning the landing attempt, and egressing out of the threat envelope, the carnage inflicted upon the three aircraft was rapidly assessed: “[E]ach had fuel leaks their self-sealing tanks couldn’t prevent because the fuel lines had been hit. Each plane had lost one of the *Osprey*’s triply redundant hydraulic

systems. Rooster 73 suffered damage to its flight controls and had an electrical system failure as well. Its cabin was awash with blood from the wounded SEALs and filled with the stench of JP-8 fuel.”⁶ Fortunately, the three aircraft were able to limp safely to Entebbe, Uganda, where the SEALs were medically evacuated to Nairobi, and aircraft returned to Hurlburt Field, Florida, for repairs. The mission, as can be assumed, was a complete failure, with what nearly ended up being disastrous results for the special operations community.

The *Osprey* has thus far in its career been known throughout the aviation community as a workhorse. “The amount of redundancy that’s build into the aircraft, the beefiness of the airplane – it’s a strong bird, and it can take some licks and keep on ticking,” stated Marine Captain David Austin during an interview in late 2014, after he was awarded the Air Medal with V for valor for a combat mission over Afghanistan.⁷ This ruggedness is one of the qualities that Marines loved when it was chosen to become the replacement for the venerable CH-46 Sea Knight; furthermore, it has been chosen in recent years as the focal point for the Marine Corps’ answer to rapidly emerging threats, the aforementioned Special Purpose Marine Air/Ground Task Forces (SPMAGTFs). Ultimately, however, without aircraft to escort the *Osprey*, especially on long-range missions, the South Sudan experience is destined to occur again. The Marine Corps must incorporate emerging forward arming and refueling concepts to present-day platforms at its own peril.

Concept Development

Even though capability brings inherent opportunities for success, and the *Osprey* certainly has had its fair share of success in its career; however, the vast distances presented in

regions that are currently supported by SPMAGTFs provide a new set of problems. Exercises and operations have been planned, briefed, and executed that included launching *Ospreys* at distances approaching their maximum range, including aerial refueling from KC-130 *Hercules* aircraft. However, these aircraft will be airborne for hours before arriving at their mission landing zones. The mission picture that presents itself can change entirely between the order to launch and the aircraft entering the terminal phase of their flight, and fortunately attempts to solve this problem have begun in earnest. One such exercise was Operation TALON REACH, planned and flown in three phases from January to July of 2014.

In late December of 2013, the Marine Corps executed the first phase of TALON REACH. The intent of the operation was threefold: to validate the Marine Corps' ability to execute a 1000+ nautical mile crisis response mission in a single period of darkness, to further develop tactics, techniques, and procedures in support of MV-22 operations into the urban littorals, and to develop and recommend improvements to the MAGTF command, control, communications, and intelligence (C3I) capabilities over those vast distances.⁸ The mission consisted of a company landing team (CLT) embarking onboard MV-22 *Osprey* aircraft, transiting from a notional SPMAGTF airfield to a notional US Embassy located onboard Fort Hood, Texas. A major capability gap was illustrated despite the mission concluding as a success. With the long-range nature of this mission, and of potential real-world tasking, there are no inherent capabilities internal to the MAGTF for long-range escort of the MV-22s. In TALON REACH, the landing zone clearance and "escort" to the assault aircraft was provided by pre-staged AV-8Bs, who launched from a nearby airfield to provide real-time imagery and on-call close air support should it be needed.⁹ In a real-world situation, the time that any aircraft can remain on the ground is

likely less than an hour. The option of pre-staging escorts, be they *Harriers*, AH-1 *Cobras*, or any other aircraft that trains to *Osprey* escort, simply will not exist.

The second and third phases of TALON REACH dealt less with the long-range capabilities of the *Osprey*, and more with gaining a foothold in enemy-held territory. Phase II focused on destruction of an enemy anti-ship cruise missile (ASCM) emplacement by ground Marines in order to allow follow-on usage of an enemy airfield by fixed wing aircraft (in this scenario, notional F-35B *Lightning II* fighters) in support of the emerging Distributed Short-Takeoff and Landing Operations, also known as DSO.¹⁰ The airfield is needed to advance base short-takeoff and landing (STOVL) aircraft in a distributed manner, akin to forward arming and refueling point (FARP) operations currently employed by rotary wing aircraft. DSO will be expounded upon later in this paper. In TALON REACH Phases II and III, company landing team objectives were protected by notional integrated air defense systems (IADS), but they were neutralized quickly, and didn't greatly impact the problem as it was presented. In fact, during TALON REACH Phase II, the air defense was quickly neutralized by combined kinetic and non-kinetic fires, and during TALON REACH Phase III, air defense artillery was located, targeted, and destroyed kinetically in order to allow freedom of maneuver for the assault aircraft.¹¹ In TALON REACH, the threat in the objective area was a significant planning factor, and in each scenario where an air threat presented itself, the threat was removed before any assault support aircraft were threatened. Yet in both, the expectation was that there *would* be a threat, and when the threat presented itself, it could be quickly and easily dealt with. Today's SPMAGTF operations do not allow much leeway in terms of threats, not only because the missions are not

being executed against near-peer enemies, but also because the MV-22s are operating without an escort.

The threat of any air defense in a landing zone immediately causes concern to *Osprey* crews. Aside from casualty evacuation missions, which have a separate go/no-go criteria in the MV-22 community, the general consensus is that any threat above a medium machine gun would likely be considered a no-go for a priority mission, unless some type of suppressive fires were available. Routine missions, such as resupply, would not land with much above small-arms in the landing zone.¹² The very issue that arose in South Sudan is destined to appear again should the Marine Corps not make an effort to provide escort to its assault aircraft while they are conducting landing zone operations. Naval Aviation's Systems Command (NAVAIRSYSCOM) in Patuxent River has recently improved MV-22B armor, adding ballistic panels to the aircraft to protect the vulnerable underside and passenger compartment, specifically thanks to an urgent universal needs statement by AFSOC.¹³ Nevertheless, this is merely a bandage applied to a hemorrhaging wound. Threat groups understand the weaknesses inherent to long-range operations such as these, and are rapidly acquiring weapons that will make missions such as these unachievable. Without any form of protection, missions will either never launch or will be forced to return to base due to the excess threat in the landing zone. As it stands today, there is only one aircraft organic to the SPMAGTF construct that can accomplish a protective mission of MV-22 Ospreys, the AV-8B *Harrier II*.

Harrier aircraft have long been considered the natural escort for long-range tiltrotor operations such as these, but have one glaring weakness: their limited fuel capacity forces dependence on external ground or airborne refueling. With an internal fuel capacity of less than

8,000 pounds, the *Harrier* is not known for its ability to remain on station for hours on end.¹⁴ In combat situations, these jets will be expected to carry external fuel tanks, increasing their fuel by a few thousand pounds. In spite of this increase of fuel, the *Harrier* just reaches the expected ranges presented in the long-range raid phase of TALON REACH. F/A-18 *Hornet* fighters do carry slightly more fuel than *Harriers*, but the inherent STOVL capabilities of *Harriers*, the habitual relationships developed onboard MEU deployments between the components of the Air Combat Element (ACE), and the present day tasking of these two aircraft show that the *Harrier* should be the preferred and supplied airframe to support MV-22s in the near future. There are two emerging concepts that should be examined in detail for applicability: Distributed STOVL Operations, or DSO, and the US Air Force's Rapid Raptor concept. What both of these concepts have in common is their keystone involves a practice well known to AV-8B aircraft: forward arming and refueling points, or FARPs.

Forward Arming and Refueling Point Operations

By now, FARP operations can be considered old hat for the US Marine Corps. Focusing on the inherent flexibility that Marines pride themselves in, the "FARP mission is to provide fuel and ordnance necessary for highly mobile and flexible helicopter and fixed-wing operations."¹⁵ Ultimately, the goal of a FARP is to minimize the response time for a fully-fueled and armed aircraft to land, rearm and refuel, and get back into operations.¹⁶ These FARPs are self-contained "pit stops" for aircraft and vehicles that include their own security, communications, force protection, and logistics, which are all scalable based on the mission. The inherent capabilities of STOVL aircraft lend themselves perfectly to this concept, and nowhere in recent

memory is this as pronounced and demonstrated as the initial weeks of Operation Iraqi Freedom and even more recently, in Operation Enduring Freedom.

As Marines pushed north in the beginning stages of Operation Iraqi Freedom, Marine Harriers conducted sustained operations from a captured Iraqi airfield at An Numinaya, only 60 miles south of Baghdad. These STOVL aircraft showed their value immediately, as the runway was cratered too seriously to support any other type of fixed-wing aircraft. The airfield also reduced response time for the jets from anywhere between one to two hours, to less than 15 minutes.¹⁷ Whether they were simply landing to rearming and refuel before taking back off or using the forward base to stand ground alert packages, combat operations in and around Baghdad were supported tremendously by the development and distribution of FARPs across the battlefield. Colonel Robert Milstead, the commanding officer of Marine Air Group 29 (MAG-29) stated his enthusiasm for these operations thusly: "...I want to pile on and say that they were the single biggest contributor to our ability to fight across 450 nautical miles of Iraq! MWSG-37 [and that group's FARPs] was *the* maneuver element of 3rd MAW – no doubt about it."¹⁸

Operations in Afghanistan had similarly impressive results, thanks to the steadfast diligence and novel usage of FARP operations by Marines. In 2009, Forward Operating Base (FOB) Dwyer was created by Marine Wing Support Squadrons a few miles from the town of Marjah. This 4,300 foot expeditionary airfield was built to "facilitate rapid logistical and fire support for the Marines operating in the southern Helmand River valley."¹⁹ The aircraft would launch from their main base in Kandahar, complete the first portion of their mission, and then recover to Dwyer to rearm, refuel, and even talk face-to-face with the ground commanders they were supporting. Their results speak for themselves: aircraft that flew in and out of Dwyer spent

65 percent of their sortie duration on station, directly supporting the ground fight; aircraft that only flew out of Kandahar and recovered back to Kandahar spent 55 percent; aircraft that launched from an aircraft carrier only 25 percent.²⁰ As can be seen, the combination of the inherent flexibility and options presented to the commander by STOVL aircraft with FARP operations is a force multiplier. It is with this understanding that the Marine Corps has developed a concept for its emerging fighter of the future, the F-35B, known as Distributed STOVL Operations.

Distributed STOVL Operations

Distributed STOVL Operations (DSO) is an emerging concept developed by the US Marine Corps to leverage the inherent capabilities of vertical/short take-off and landing (V/STOL) aircraft in a potentially denied area of operations.²¹ This denied area of operations lies underneath both known and unknown threat weapon systems, and will have few existing runways, airfields, and bases in which to operate from. This emerging anti-access/area-denial (A2/AD) situation is the expected scenario should the United States find itself in a conflict with a near-peer rival, and DSO is designed to counter this problem. “Joint amphibious challenges with dispersed aviation support from STOVL aircraft will be a critical tool in countering A2/AD challenges...” said Colonel Vance Cryer, a former requirements officer in the Pentagon, commanding officer of a Harrier squadron, and current Commanding Officer of a Marine Expeditionary Unit.²² DSO’s definition in the fiscal year 2015 Aviation Plan is as follows: “DSO is a threat-based limited objective operation which occurs primarily when the entire MAGTF cannot be brought to bear against the enemy.”²³ The concept also states, “Distributed STOVL Operations, the subject of the CONOPS being drafted, employ STOVL aircraft in a distributed

force posture independent of fixed infrastructure, which allows the Marines to move aircraft around a battlefield in order to undermine an enemy's intelligence on that force posture."²⁴ In other words, DSO enables the flexibility of STOVL aircraft to their utmost. However, and perhaps most importantly when examining and later assessing DSO's applicability to the present situation faced by SPMAGTF, are two major factors that must be addressed: the logistical footprint required, and the personnel needed to accomplish this operation.

The impact DSO can bring to a scenario or a threat country is immense. The concept is scalable, from an air-only option on the small end of the spectrum to a heavy, operational-level option that incorporates major logistical capabilities normally reserved for theater-level operations.²⁵ Having multiple 5th generation fighters operating from bases with unknown locations surely will cause justified concern to the enemy commanders, interfering with his course of action. The interruption of the typical targeting cycle is one such way the enemy commander is disrupted. The amount of time required to re-target long-range missiles, have confirmation that the targeted vehicles, assets, or infrastructure is at the aforementioned location, and the weapon release process is immense compared to the relatively small time required to displace few aircraft and support equipment outside the expected weapon damage area. Understanding the theater of operations is a baseline level of knowledge, especially when examining the space and area requirements to conduct such operations.

A key component of DSO is leveraging existing infrastructure to suit its needs. Whether using highways, large parking areas, dirt strips, unimproved landing sites, or even rapidly constructed landing areas provided by the Marine Wing Support Squadron, the typical requirement for a massive logistical and C2 (Command and Control) footprint is mitigated. It is

precisely this flexibility that creates opportunities both offensively and defensively for the MAGTF. Offensively, enabling the situational awareness picture fusion between the F-35B, theater assets, airborne warning and control system aircraft (AWACS), and legacy aircraft will allow targeting and weapon employment at a scale unseen in warfare until now. DSO is akin to a fisherman casting a net from a beachfront, and each section of the net is an F-35 collecting, analyzing, disseminating, and passing information to the other assets on the network. Defensively, the FARPs created can be scalable in the time they are able to be used--they can be set up, refuel, and rearm jets and then be broken down, or they can persist for days once the threat has been either mitigated or neutralized. DSO is indeed a concept worthy of further development, especially due to the flexibility provided to the commander. However, having flexible and maneuverable assets in place to enable DSO is no small measure, and is something friendly commanders of the future will certainly need to leverage.

Since the hypothetical scenario (discussed later) is designed with the SPMAGTF operational construct in mind, an air-only option will be used to illustrate the size of the support structure for DSO. As seen in preliminary reports, the amount of manpower and equipment is much larger than the handful of trucks or a single CH-53E helicopter landing and conducting refueling operations. For a single section of F-35Bs, there is a requirement for two CH-53K *King Stallion* heavy lift helicopters equipped with the theater bulk fueling distribution system, or TBFDS. Additionally, two MV-22B *Osprey* aircraft are required for ordnance and maintenance functions, and two more *Ospreys* for security of the FARP. Should the CH-53K be unable to reach the FARP, which for scenarios such as the one presented here would be feasible, conservative estimates would use a 2:1 ratio for comparing fuel capabilities with the CH-53K

and the MV-22Bs. Essentially, should the air-mobile FARP be chosen as a course of action, it would take a significant amount of the current-day table of organization and equipment away from a MEU or SPMAGTF. This mission, as the creators of DSO have acknowledged, becomes the main effort of the entire MAGTF.

Rapid Raptor / Fighter FARP Operations

The US Marine Corps is not the only service in the Department of Defense to be concerned about a potential A2/AD threat in the coming future. Where the Marine Corps uses a general threat context to illustrate the concept and its possible uses, the US Air Force focuses specifically on the Western Pacific Theater of Operations, or the WPTO. The Air Force understands that should the United States and China enter into conflict, the scenario illustrated earlier in the DSO concept would likely become reality. Their answer to the A2/AD threat is a concept called Rapid Raptor. This concept “combines sortie-generation capabilities and mobility support to enable more expeditionary and dispersed operations,” and “includes rearming, refueling, and swapping pilots without the use of airfield infrastructure.”²⁶ The concept, which acknowledges that FARP operations are not only not a new concept, but also currently trained to in the Air Force, aims to take current capabilities and apply them in an innovative fashion.²⁷ This includes pairing “a four-ship of fighters with a transport aircraft, making use of [a] FARP to rearm, refuel, and swap pilots at over 250 possible locations throughout the WPTO.”²⁸ A major point of departure from DSO to Rapid Raptor is the usage of strategic lift aircraft, in this case, the *C-17 Globemaster III*.

Inside the C-17 is a literal laundry list of items brought to the fight. As opposed to the relatively spartan capacity in the *Osprey*, these aircraft “contain a prioritized parts kit, munitions for rearming, a forward area manifold (FAM) cart to regulate fuel pressure from its internal tanks to the fighters, additional pilots to rotate into the fighter cockpits, and trained personnel to conduct fuel, weapons, and maintenance functions.”²⁹ Indeed, the C-17 will carry everything that DSO requires a half-dozen helicopters and tilt rotor aircraft to accomplish, and still has enough fuel and weapons available for multiple sorties. Comparatively speaking, the quantity of material that can be carried is akin to comparing a shopping cart to the entire grocery store when comparing the MV-22B and the C-17. Another factor to consider is the longevity of the operations conducted with Rapid Raptor. Per the initial planning, there are a number of considerations in regards to the length that which the operations can be conducted, but these types of operations are expected to be limited to three total days.³⁰ This limitation is presumably based upon both maintenance and fuel capacity, whereas the fighters will require maintenance after a certain number of sorties and flights, and the C-17 will require refueling to its internal tanks. The limitation on fuel has been improved since 2000, when modifications were made to the internal fuel capacity of all follow-on C-17s. Since the delivery of the 71st aircraft, all C-17s now utilize an extended-range fuel tank containment system (ERFCS), which for the purposes of this discussion simply add fuel capacity, and in effect, fuel offload.

These C-17s will require a runway around 3,000 feet for landing and near immediate application of their engine-mounted thrust reversers. Ideally, the terrain they use will be somewhat improved, but their ability to use unimproved, dirt, even grass strips is a key component of this aircraft’s flexibility. Once the aircraft stops, however, a significant amount of

support, whether in the form of force protection, communications, or enablers will be required. Fortunately, if there is one thing that the C-17 provides over the aforementioned *Osprey* aircraft it is capacity. As can be seen from the discussion above, the amount of combined fuel and payload brought to the fight by the C-17 aircraft is immense. Typical Rapid Raptor load outs contain enough weapons for between two and four sorties from each aircraft, threat dependent, and provide sustainment packages once the initial load outs are expended.³¹ Additionally, the timelines provided by Rapid Raptor planners from C-17 landing and set up, to the fighter landing, rearm and refueling, and then subsequent launches is still under development, but with expected maintenance and personnel packages it is not too far removed from reality to think that sorties could be planned inside of the usual 2 hour 30 minute to 3 hour turnaround window currently used by squadrons worldwide.

The Spider FARP

As has been seen already, both the Marine Corps and Air Force see the need for distributed operations in a future conflict scenario, one that pits the United States against an adversary with near-peer to peer capabilities. A key facet of these operations is their dependence on 5th generation aircraft in the F-35B and the F-22. Due to the equity expected in these conflicts, every advantage possible is desired to be employed, thus the emphasis on these fighter aircraft with emerging technological advantages. However, there is an executable option that is ready now, evolving out of operations conducted during the MAWTS-1 Weapons and Tactics Instructor Course that can be adopted immediately known as Spider FARPs .

Present MEU operations are limited by the maximum unrefueled range of the organic aircraft due to a lack of a dedicated tanker aircraft, in spite of the “tether” concept, whereas KC-130J *Hercules* aircraft are expected to be ready and available for tasking by their respective supported MEU Commander. The fact remains, nevertheless, that with the present operational tempo, the KC-130 community is in extremely short supply. The current lack of these vital airframes cannot be understated: the KC-130J is the only fixed-wing legacy airframe in the current inventory that is expected to increase in quantity by over twenty aircraft over the next ten years.³² Nonetheless, planners and commanders must adapt and confront missions with the assets on hand, and recent memory shows an example immediately after Operation Enduring Freedom began by the operations of Task Force 58.

Task Force 58’s operation in 2001, where the force was directed to seize a forward operating base (FOB) over 300 nautical miles inland, showed the abilities of the MEU aircraft in a scenario where KC-130s were not available. Due to aircraft fuel and range limitations, multiple FARPs were required to be created to extend the reach of the assault support assets proceeding inland over Pakistan.³³ Distances like this will become the norm in the battlefields of the near future, and the Spider FARP concept’s mission is to “demonstrate a capability to provide an agile and flexible basing option for strike aircraft that projects firepower further into the battlespace than conventional sea-based options.”³⁴ This mission was indeed without precedent; however, as DSO and Rapid Raptor show, FARP operations consisting solely of aviation platforms are in very high demand.

Spider FARP operations are intended to be of minimal duration, with a small support package, and with little to no external support. The concept has been designed with the goal of

providing a flexible basing option for strike aircraft, scalable package compositions, and a focus on employment of aircraft already resident in the Marine Expeditionary Unit. Not surprisingly, the concept focuses on the two most heavily deployed aircraft in the Marine inventory: the MV-22B and AV-8B. In the spring of 2014, MAWTS-1 launched two AV-8B *Harriers* on a strike mission with two GBU-38 (500-pound) JDAM (Joint Direct Attack Munition) weapons, and after conducting a strike mission recovered them to an austere location north of MCAS Yuma at Laguna Army Air Field. Upon landing, the *Harriers* cleared the active runway, and taxied to two waiting MV-22B aircraft with fuel hoses and ordnance waiting. The operation to recover, refuel, rearm, and launch these two aircraft was completed in less than an hour, to include launching the *Osprey* aircraft back to Yuma. Spider FARPs take the flexibility of FARP operations, to include their dispersed and distributed natures, and add capability for offensive air support missions to be launched from a smaller area. Due to omnipresent desires for minimally invasive operations, especially ones that potentially could be carrying high explosive ordnance, small operations like these are very attractive to both planners and commanders. Unfortunately, the total size of operations limit the sortie generation to only a single additional sortie for each *Harrier*, which may or may not be acceptable based on the commander's overall intent for the MV-22B operation.

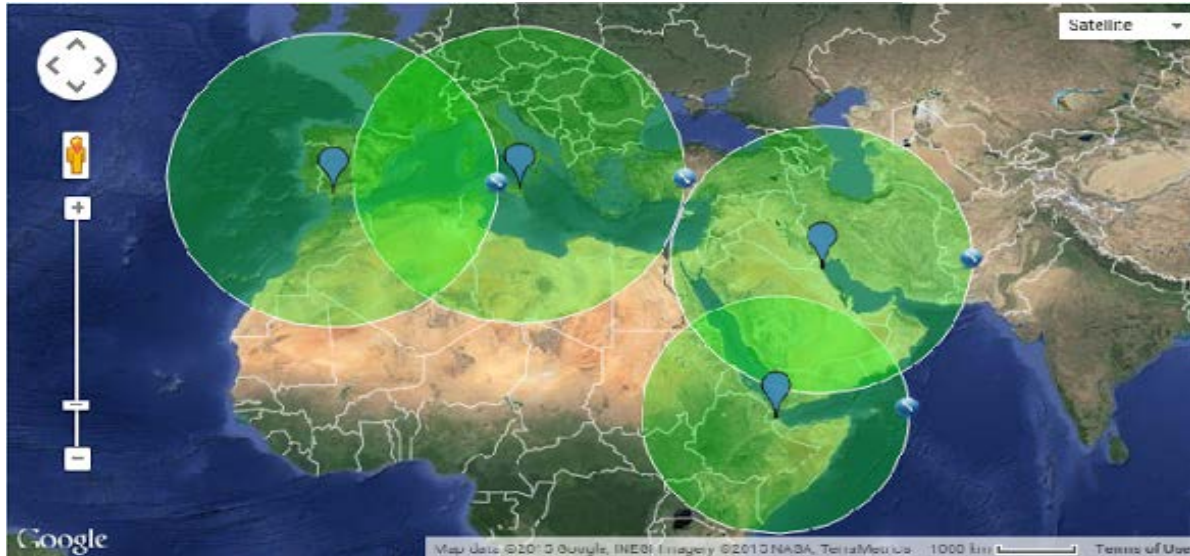
What Spider FARPs allow is the advantage of the two operational concepts in a more compressed execution window. These FARPs show the flexibility that using aviation assets, be they MV-22B or C-17 aircraft, can provide the commander when looking at FARP operations. The aircraft can land, unroll hoses and prepare munitions, and both rearm and refuel fighter-sized aircraft in an extremely short time span. Application of Spider FARP concepts to the

operational-level plans in DSO and Rapid Raptor is necessary, and the results should be made available to planners.

Threat Scenario: The 1,200 Nautical Mile Extraction

In examining DSO and Rapid Raptor for implementation, planners have deliberately have been ambiguous in their usage and real-world application. What both do have in common is the application against a threat that can create an anti-access/area-denial (A2AD) environment, but that environment is not one known today. Today's fight is not against a "near-peer" threat akin to the USSR during the Cold War, but instead against global terrorist networks or insurgencies interior to allied countries. Organizations like these seem to multiply by the day. Boko Haram, located in Nigeria, is known to the world by their brutality in Nigerian rural areas of Borno province and their kidnapping of school-age girls. Al-Qaeda in the Islamic Maghreb, a group with direct ties to al-Qaeda, is located throughout northern Africa, and is presumed to be regrouping for major offensives after recent French interventions. Al-Shabab, another affiliate of al-Qaeda located in Somalia, has claimed responsibility for the September 2013 Westgate Mall attack which killed dozens. Finally, Joseph Kony's Lord's Resistance Army, located in South Sudan and the Central African Republic, is known for rampant murder, rape, and child enslavement.³⁵ Yet these are only the groups in Africa. The Middle East region is dominated today by news of the Islamic State (also referred to as ISIL or ISIS), al-Qaeda in the Arabian Peninsula, and above all, the original al-Qaeda in Pakistan and Afghanistan. Needless to say, these two areas are rife for extremist conflict.

Nowhere within foreign territory is a more visible visage of the United States than embassies. Essentially existing to support American interest in-country, they are sovereign territory and are treated as such by their own respective force protection postures. Marine guards defend these compounds, which can be as small as a single building or as large as a miniature city. Should they come under attack or fire, appropriate defense plans are implemented, but when extraction is required, the embassy is entirely dependent on either the local governance to assist in evacuation or the military. However, before Benghazi, the only units that trained to evacuate embassies were MEUs. Now that the SPMAGTF operations are in full swing, these units typically will forward deploy to increase their force protection posture and response time. It is also not unlikely that the aforementioned TALON REACH operations are too far from reality when it comes to long-range embassy reinforcement or extraction. Below is a map of the SPMAGTF areas of operation with 1,200 nautical mile distance rings overlaid to show the possible ranges by units launched from four primary locations: Moron, Spain; Sigonella, Sicily; Camp Lemonnier, Djibouti; and finally Al Jabr Airbase, Kuwait



(Image copyright Google Earth, 2015)

As it stands, these 1,200 nautical mile rings ideally place SPMAGTF forces within striking distance of a great number of American embassies. Use of expeditionary airfields within these areas of operation in other regions will essentially cover the entirety of central to northern Africa. On the other hand, these forces are also well within the areas of influence and operations that extremist groups occupy. It is not a stretch of the imagination to think that based on historical trends and likely operational goals, extremists will again attempt to penetrate the defenses of an embassy somewhere in the African continent or Middle East. The Marine Corps will be ready with its SPMAGTF units within a few hours flight time. What cannot be forgotten is the result of the 2013 South Sudan raid. In the event an embassy is under siege and withdrawal requested by the local Ambassador, answering with a “no” is simply not acceptable.

Feasibility and Supportability

Now that a basic understanding of the situation, the options, and the capabilities available to commanders has been shown, it is necessary to evaluate each concept's strengths, weaknesses, and applicability. This paper will evaluate these concepts within the framework of warfighting functions, specifically maneuver, fires, logistics, force protection, and intelligence. Maneuver will focus on the respective concept's ability to provide escort aircraft for the MV-22s, both pre- and post-landing in the zone, along with providing support for any contingency situations that may arise. Fires will focus on the ability of the concept to provide timely precision fire support with a minimum of delay or restriction. Logistics will examine each concept's ability to maximize capabilities with a minimum of platform requirements; in other words, doing more with less. Force protection examines the ability of each concept to protect itself, both before and after seizing the respective FARP. Finally, the examination of intelligence focuses on the ability of the concept to provide timely, accurate, and credible information to support both the *Osprey* operations and the escorts. The specifics of each concept are not the intent of this paper to show; rather, a general idea of conceptual basics should allow future planners a framework to expand upon.

No scenario is complete without real-world limitations, constraints, or restraints. As such, the limits for this scenario are as follows: a single KC-130 will be allocated to extend the range of the AV-8B transit along a 1,200 nautical mile leg, the landing area for the FARP will be in a permissive environment, and the AV-8Bs will need to be on station during a minimum window of one hour, which will require both pre- and post-mission FARP operations. Most notably to this scenario is the lack of available Marine KC-130J aircraft to support the operation

with rapid ground refueling, or RGR. Due to the range required, these aircraft will be unable to transit one way, give fuel, and return to their base without stopping at an intermediate basing facility. Also, these aircraft would be considered “theater-level” assets; in other words, they will be tasked out by the combatant commander, and may not be available due to their limited airframe density. It is much more likely that the more numerous and more capable C-17 airframes will be available for tasking, and as is desired in all operations, the combatant commander should place the best platform for the mission.

To begin with, maneuverability in this scenario is extremely important. The current problem hinges in the inability of the MV-22B aircraft to support themselves within the confined landing environment, and each concept’s ability to support escort operations. DSO certainly provides distributed FARP operations, but at a pretty significant cost. Within the construct of even the smallest M-FARP template, the assets required will bankrupt the remainder of any additional operations requested or required of the SPMAGTF. Application of Rapid Raptor can provide all capabilities inherent in DSO and then some. With flexibility and maneuverability in mind, the C-17 will provide more “bang for the buck” per airframe over DSO’s requirement for half a squadron’s worth of *Ospreys*.

Providing timely and precise fires is as important to the operation as being on station to begin with. Due to the single machine gun provided for self-defense, the MV-22B must have some extra firepower provided in the event that upon conversion into helicopter mode, the ubiquitous Toyota Hilux with a medium or heavy machine gun doesn’t prevent mission accomplishment. Ignoring the earlier discussion on bankruptcy of the SPMAGTF aviation assets available for other missions, each of these concepts provides sufficient weapon loadouts for a

section of *Harriers* to employ ordnance, have an additional section ready to relieve them should they go “winchester,” or run out of PGMs (precision guided munitions), and ordnance to provide effective escort back to base.

“Amateurs do tactics, professionals do logistics” is a common joke among logisticians. In this scenario, the desire is to minimize the quantity and emplacement size of the logistical support required in order to maximize additional missions that can be supported by the SPMAGTF. Essentially, the less moving parts required, the easier and more likely to be accomplished the mission is. DSO will be a massive undertaking, with parts, fuel, ordnance, and Marines spread over a significant amount of aviation assets, whose only mission is to support the escorts. It must not be forgotten that the primary mission of this scenario is to evacuate or reinforce via MV-22B, not to support fires. Rapid Raptor, however, brings everything required in one aircraft, whether it is fuel, weapons, Marines, or other enablers to conduct the mission. Finally, the space required by one C-17 is nowhere as complicated as a 6 or 8-ship package of *Ospreys*, who will need to coordinate landing, taxiing, setting up, and so on while under a compressed timeframe.

Force protection may be the most important function due to the sensitivity presented by long-range missions with limited capabilities for support. The packages must be self-sustaining and supporting, which will mean security will be paramount once the aircraft land and begin conducting their offload operations. DSO does provide for security, in fact, it provides between a squad and a platoon of Marines with the sole purpose of defense of the Mobile FARPs. Additionally, Marines from the LAAD (Low Altitude Air Defense) detachment are included, providing air defense of the vulnerable aircraft. Rapid Raptor, while certainly containing enough

support personnel for all other functions on deck, does not currently provide much security for the C-17 once it is on deck above a small contingent of security force airmen. The assessment of risks presented herein will require advance site reconnaissance no matter what platform is chosen, and will likely be augmented with critical enablers to include communications, any desired or required combat controllers, meteorological forecasters, and so on. Ultimately, the damage or loss of any airframe in this scenario could be disastrous, and must be tempered with the commander's risk assessment and level of acceptance.

Finally, providing a real-time picture of the situation on deck is of extreme importance, as without a picture of the developing crisis, Marines and aircraft are essentially flying blind. TALON REACH has made recommendations on improvements to capabilities inherent in the MAGTF for intelligence updates, but as was mentioned, those systems and capabilities are still years off. DSO does take into account intelligence planners and debriefers, especially due to the potential for these M-FARP operations to persist longer than a few hours. Also, intelligence provided by the F-35B aircraft will digitally download to the intel section, further building local target situational awareness. All this information is certainly going to help the Marine Corps when DSO is fully executable, but the systems and capabilities are not currently resident in the SPMAGTFs. Rapid Raptor includes limited intelligence personnel, instead focusing on targeting provided to the fighters once airborne via E-3 Sentry AWACS (Airborne Warning and Control System) aircraft via digital or radio communications.

Recommendations and Conclusion

Distributed STOVL Operations is a concept with some significant interest behind it. In fact, the FY2015 Marine Aviation Plan specifically discusses DSO, in spite of the expected timeframe of employment being close to a decade away.³⁶ DSO and its Mobile FARP, even as an air-only option, are simply too large of a footprint to apply to present-day SPMAGTF operations. Additionally, the impact losing this quantity of Marines would have on a present-day squadron is tremendous. As the majority of the ordnance and maintenance Marines would come from the Harrier itself, it is appropriate to assume that a mission, should it be executed with DSO data and concepts in mind, would prevent any additional operations from being executable. With the personnel issues, and the fact that any additional missions planned for by the SPMAGTF would have to wait until the FARP mission supporting the MV-22Bs was complete, one final conclusion can be assessed: DSO, while an excellent concept and one that surely will gain traction upon approval, requires too many assets to be employed in the SPMAGTF today.

Spider FARP, are an excellent concept for small, limited-time strike packages to rearm and refuel with limited impact on local operations. Conceptually, the premise of having the flexibility and capability of *Osprey* aircraft supporting *Harrier* operations is a great match. Unfortunately, for the situation presented and the desire to avoid a repeat of the 2013 South Sudan mission failure, there is too little provided for the audible footprint, the size of the landing area required, and the time required on deck to refuel and rearm. Similar to the issues with DSO, Spider FARP, are not supportable by current-day SPMAGTF operations without significant increases to the manning and aircraft complement brought to the fight. If the mission was a short-duration desire to having *Harriers* rapidly rearmed and refueled within a range of a few

hundred miles, or with additional joint tanker assets available, Spider FARPs would be an outstanding option. An even more desirable option is for the Marine Corps to fund an innovative addition to the MV-22B called the “aft sponson.” This simple addition, which has been requested since 2008 by *Osprey* crews, can be installed to add an additional 2050 pounds of available fuel without a loss of cabin space. In fact, this item has been in the OAG’s top 10 for years, but has yet to be funded.³⁷ A section or division of aircraft equipped with this modification would not only support additional range for the assault package, but also should the escorts require more fuel, it would absolutely help the *Harriers* stay on station longer in support.

Rapid Raptor is simply the better of the two options for this mission set. It can bring the capacity and equipment that make DSO an appealing option, along with an ability to get in and out of a FARP area within a minimal amount of time. Fuel, weapon, and personnel quantity are no issue, and the only roadblock to incorporation is familiarity between the USAF crews and the Marines conducting the mission. Therein lays the largest issue with this idea: in order to request and receive C-17 aircraft, there will need to be a significant amount of paperwork and approval granted between the two services. In addition, the operation will transition from being entirely Marine in nature, simplifying command and control, to potentially becoming a joint operation. This is not a foregone conclusion, however, and there are plenty of examples of Marine/Air Force operations conducted with small packages of assets from each service.

A joint Marine/Air Force operation like this begs the opportunity for further development. As Operation Enduring Freedom and associated major conflict winds down, both the Marine aviation communities and Air Force Air Mobility Command have newfound “white space” in their training plans to work interoperability. In fact, thanks to planners at the Hawaii

Air National Guard, load plans already developed for F-22 *Raptor* aircraft, to include multiple mission sets, can be adjusted for *Harrier* aircraft, maintenance parts, personnel, and ordnance. Long-range operations like these will become the norm in the “new normal,” if for no other reasons than the inherent desires for insurgent or terrorist operations to occur at ranges away from American forces. Military planners owe the Marines sent into harm’s way the support they deserve, and a joint operation with Marine *Harriers* and Air Force C-17 *Globemaster III* aircraft can give the assault aircraft something not currently enjoyed: long-range escort, on-demand fire support, and increased capabilities in the landing zone.

Airframe Capability Comparison		
Platform		Notes
MV-22B	Weapon Carriage	4 GBU-38 per aircraft (Ordnance Only)
	Fuel Offload	~2000 pounds (Fuel + Ordnance)
		~6000 pounds (Fuel Only)
	Airspeed	240 Knots
	Passengers	18 Marines
	Range	~900 Nautical Miles
	Altitude	<14,000 feet
	Notes	MV-22B aircraft have FARE (Forward Area Refueling Equipment) kits installed. Aircraft can proceed to LZ, but will require aerial refueling for enroute and return legs. Ordnance Marines will hand load all weapons due to lack of ordnance gear (SATS loaders, etc). Total time on deck could be (with fully trained crews on all aircraft) less than 90 minutes total.

Appendix 1: MV-22B FARP Capabilities

Airframe Capability Comparison		
Platform		Notes
C-17	Weapon Carriage	16 GBU-38 per aircraft, 8 AIM-9M
	Fuel Offload	>100,000 pounds
	Airspeed	>350 Knots
	Passengers	40
	Range	TBD
	Altitude	>30,000 feet
	Notes	C-17 aircraft can be fitted with more ordnance or personnel, should less of either be desired. Includes FAM (Forward Area Manifold) to offload fuel, 1 squad of USAF security forces, ordnance Marines, and maintenance Marines.

Appendix 2: C-17 FARP Capabilities

Endnotes

- ¹ Headquarters, U.S. Marine Corps, “FY2015 Marine Corps Aviation Plan,” Washington, DC: Headquarters, U.S. Marine Corps Aviation, 2015, 10.
- ² Paul Jackson, *Janes All the Worlds Aircraft 2011-2012* (Janes Information Group, Alexandria), 2011, 648.
- ³ Luis Martinez, ABC News, “Three US Military Planes Take Fire in South Sudan, Four Injured,” December 21, 2013, <http://abcnews.go.com/blogs/politics/2013/12/two-us-military-planes-take-fire-in-south-sudan-four-injured/>
- ⁴ Richard Whittle, “MacKay Trophy For AFSOC Osprey Crews: A Tale Of Bullet Riddled Planes.” November 3, 2014, <http://www.military.com/daily-news/2014/11/03/mackay-trophy-for-afsoc-osprey-crews-a-tale-of-bullet-riddled-p.html>
- ⁵ Whittle, 2.
- ⁶ Whittle, 2.
- ⁷ Whittle, 3.
- ⁸ Headquarters, US Marine Corps, Marine Corps Center for Lessons Learned, “IOC Operation TALON REACH After Action Report,” January 27, 2014, 2-4.
- ⁹ Headquarters, US Marine Corps, Marine Corps Center for Lessons Learned, “IOC Operation TALON REACH After Action Report,” January 27, 2014, 8.
- ¹⁰ Headquarters, US Marine Corps, Marine Corps Center for Lessons Learned, “IOC Operation TALON REACH II After Action Report,” April 21, 2014, 2.
- ¹¹ Headquarters, US Marine Corps, Marine Corps Center for Lessons Learned, “IOC Operation TALON REACH III After Action Report,” July 29, 2014, 7.
- ¹² Major Trong Do, email to author, January 12, 2015.
- ¹³ NAVAIRSYSCOM, “Flight Ready: AIRworks in action: CV-22 Ballistic Protection,” YouTube Video. <http://youtu.be/YqNvHf92knw>.
- ¹⁴ Paul Jackson, *Janes All the Worlds Aircraft 2011-2012* (Janes Information Group, Alexandria), 2011, 648.
- ¹⁵ Headquarters U.S. Marine Corps, *Aviation Ground Support*, MCWP 3-21.1, Washington, DC: Headquarters U.S. Marine Corps, October 16, 2001: 7-1.
- ¹⁶ Headquarters U.S. Marine Corps, *Aviation Ground Support*, MCWP 3-21.1, Washington, DC: Headquarters U.S. Marine Corps, October 16, 2001: 7-1
- ¹⁷ Tyler Bardo and Chad Vaughn, “Flexible Future: The F-35B will give the Marine Corps unprecedented basing options,” *Armed Forces Journal*, (October 1, 2010): 3. <http://www.armedforcesjournal.com/flexible-future/>
- ¹⁸ Jay A. Stout, *Hammer From Above: Marine Air Combat over Iraq*, New York: Presidio Press, 2005: 157.
- ¹⁹ Tyler Bardo and Chad Vaughn, “Flexible Future: The F-35B will give the Marine Corps unprecedented basing options,” *Armed Forces Journal*, (October 1, 2010): 3-4. <http://www.armedforcesjournal.com/flexible-future/>
- ²⁰ Tyler Bardo and Chad Vaughn, “Flexible Future: The F-35B will give the Marine Corps unprecedented basing options,” *Armed Forces Journal*, (October 1, 2010): 4. <http://www.armedforcesjournal.com/flexible-future/>
- ²¹ Brett McGregor, “MAGTF Distributed STOVL Operations (DSO),” Washington, DC: Headquarters U.S. Marine Corps Aviation Plans, Policy, and Operations, 2014.
- ²² Marina Malenic, “USMC Drafts key F-35B operational concept,” *Jane’s Defense Weekly* 51.26 (May 21, 2014): 2.
- ²³ Headquarters, U.S. Marine Corps, “FY2015 Aviation Plan,” Washington, DC: Headquarters, U.S. Marine Corps Aviation, 2015.
- ²⁴ Marina Malenic, “USMC Drafts key F-35B operational concept,” *Jane’s Defense Weekly* 51.26 (May 21, 2014): 2.
- ²⁵ Brett McGregor, “MAGTF Distributed STOVL Operations (DSO),” Washington, DC: Headquarters U.S. Marine Corps Aviation Plans, Policy, and Operations, 2014.
- ²⁶ Robert D Davis, “Forward Arming and Refueling Points for Fighter Aircraft – Power Projection

-
- in an Antiaccess Environment,” *Air and Space Power Journal*, (September-October 2014): 6.
- ²⁷ Robert D Davis, “Forward Arming and Refueling Points for Fighter Aircraft – Power Projection in an Antiaccess Environment,” *Air and Space Power Journal*, (September-October 2014): 10-11.
- ²⁸ Robert D Davis, “Forward Arming and Refueling Points for Fighter Aircraft – Power Projection in an Antiaccess Environment,” *Air and Space Power Journal*, (September-October 2014): 11.
- ²⁹ Robert D Davis, “Forward Arming and Refueling Points for Fighter Aircraft – Power Projection in an Antiaccess Environment,” *Air and Space Power Journal*, (September-October 2014): 11.
- ³⁰ Robert D Davis, “Forward Arming and Refueling Points for Fighter Aircraft – Power Projection in an Antiaccess Environment,” *Air and Space Power Journal*, (September-October 2014): 17.
- ³¹ PACAF Planner (get his name in here), MAJ USAF. Email to author, dated 24 February 2015.
- ³² Headquarters, U.S. Marine Corps, “FY2015 Marine Corps Aviation Plan,” Washington, DC: Headquarters, U.S. Marine Corps Aviation, 2015, 51.
- ³³ Vincent Goulding, “Task Force 58: A higher level of naval operation.” *Marine Corps Gazette* 95, 8. (August 2011): 39.
- ³⁴ Marine Aviation Weapons and Tactics Squadron One. “MEU Organic Spider FARPS.” *Dragon Journal*. Edition 17: June 2014.
- ³⁵ ABC News. “Key Terrorist Groups in Africa.” <http://abcnews.go.com/Blotter/fullpage/african-terrorist-groups-infographic-23610960>.
- ³⁶ Headquarters, U.S. Marine Corps, “FY2015 Marine Corps Aviation Plan,” Washington, DC: Headquarters, U.S. Marine Corps Aviation, 2015.
- ³⁷ Maj Eric Keith, USMC. Email to author dated January 20, 2015

BIBLIOGRAPHY

- ABC News. "Key Terrorist Groups in Africa." <http://abcnews.go.com/Blotter/fullpage/african-terrorist-groups-infographic-23610960>.
- Anonymous. "USAF airmen evaluate Rapid Raptor concept in Guam." *Progressive Digital Media Defense News*. (December 5, 2014)
- Bardo, Tyler and Vaughn, Chad. "Flexible Future: The F-35B will give the Marine Corps unprecedented basing options." *Armed Forces Journal*. (October 1, 2010). <http://www.armedforcesjournal.com/flexible-future/>
- Beard, Benjamin, Maj USMC. Email to author dated January 27, 2015.
- Commander and Staff, MWSG-37. "No FARP Too Far!". *Marine Corps Gazette*. Vol 87, 5. December, 2003: 24-27.
- Colvert, Ryan B. "Preparing the Fleet for F-35B." Master's Thesis, Marine Corps University, 2012.
- David, David. DVIDS. "Marines secure departure of Tripoli Embassy personnel." July 26, 2014. <http://www.dvidshub.net/news/137394/marines-secure-departure-tripoli-embassy-personnel#.U9fq5fldVP8#ixzz38stX8eud>
- Davis, Robert D. "Forward Arming and Refueling Points for Fighter Aircraft – Power Projection in an Antiaccess Environment." *Air and Space Power Journal*. (September-October 2014): 5-28
- Goulding, Vincent. "Task Force 58: A higher level of naval operation." *Marine Corps Gazette* 95, 8. (August 2011): 38-41
- Headquarters, US Marine Corps. "IOC Exercise TALON REACH I AAR." Marine Corps Center for Lessons Learned. January 27, 2014.
- Headquarters, US Marine Corps. "IOC Exercise TALON REACH II AAR." Marine Corps Center for Lessons Learned. April 21, 2014.
- Headquarters, US Marine Corps. "IOC Exercise TALON REACH III AAR." Marine Corps Center for Lessons Learned. July 29, 2014.
- Headquarters U.S. Marine Corps. *Aviation Ground Support*. MCWP 3-21.1. Washington, DC: Headquarters U.S. Marine Corps, October 16, 2001.

Headquarters U.S. Marine Corps. *Marine Corps Operations*. MCDP 1-0. Washington, DC: Headquarters U.S. Marine Corps, August 9, 2011.

Headquarters U.S. Marine Corps. *2015 Marine Corps Aviation Plan*. Washington, DC: Headquarters, U.S. Marine Corps. 2015.

<http://airportnavfinder.com/index.php?op=map>. Airports in theater of scenario. Accessed January 25, 2015.

Jackson, Paul. *Janes All the Worlds Aircraft 2011-2012*. Janes Information Group, Alexandria. 2011

Keith, Eric, Maj USMC. Email to author dated January 20, 2015

Martinez, Luis. ABC News, “Three US Military Planes Take Fire in South Sudan, Four Injured.” December 21, 2013. <http://abcnews.go.com/blogs/politics/2013/12/two-us-military-planes-take-fire-in-south-sudan-four-injured/>

Malenic, Marina. “USMC Drafts key F-35B operational concept.” *Jane’s Defense Weekly* 51.26 (May 21, 2014).

Marine Aviation Weapons and Tactics Squadron One. “MEU Organic Spider FARPS.” *Dragon Journal*. Edition 17: June 2014.

McElhaney Jr., Richard, MAJ USAF. Email to author, dated 24 February 2015.

McGregor, Brett. *MAGTF Distributed STOVL Operations (DSO)*. Washington, DC: Headquarters U.S. Marine Corps Aviation Plans, Policy, and Operations, 2014.

Meek, James. “22 MEU PTP Lessons Learned.” Marine Corps Center for Lessons Learned. April 7, 2009.

Murray, Williamson and Millett, Allan R. *Military Innovation in the Interwar Period*. Oxford: Cambridge University Press. 1998.

NAVAIRSYSCOM. “Flight Ready: AIRworks in action: CV-22 Ballistic Protection.” YouTube Video. <http://youtu.be/YqNvHf92knw>.

Stout, Jay A. *Hammer From Above: Marine Air Combat over Iraq*. New York: Presidio Press. 2005.

Svetska, Mark. Email to author, dated 24 February 2015

United States Central Command. “Marines stand up Special Purpose Marine Air Ground Task Force.” <http://www.centcom.mil/en/news/articles/marines-stand-up-special-purpose-marine-air-ground-task-force>. Accessed January 17, 2015.

Whittle, Richard. “MacKay Trophy For AFSOC Osprey Crews: A Tale Of Bullet Riddled Planes.” November 3, 2014. <http://www.military.com/daily-news/2014/11/03/mackay-trophy-for-afsoc-osprey-crews-a-tale-of-bullet-riddled-p.html>