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14. ABSTRACT In 1929 the Army Air Corps' "Question Mark" project completed its first successful airborne refueling operation, 26 years after the Wright brother's infamous flight at Kitty Hawk, North Carolina. In contrast, the world has gone 105 years without a means to rearm while airborne since aircraft were first used to drop explosives in 1911. Now is the time to develop mid-air rearming. In today's environment, an armed UAS is relegated to perform ISR duties after its munitions have been expended. However, if the UAS is mid-air rearmable then it can maintain its armed presence and diminish the need to task additional aircraft, making this capability a force multiplier with impacts at multiple levels of war. At the strategic level, it may expand the number of foreign nations that allow US UASs to operate from their borders. At the operational level it provides an effective means to maximize combat power. At the tactical level because it will enable weeks of persistent armed-coverage and on-call fires to ground troops. Mid-air rearming's unique ability to affect all three levels of war proves that the US should invest its time, money and resources into developing this capability.					
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FUTURE WAR PAPER

*Unmanned Aerial Systems
Mid-Air Rearming:
a 21st Century "Question Mark"*

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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In 1929 the Army Air Corps' "Question Mark" project completed its first successful airborne refueling operation, just 26 years after the Wright brothers used fuel to power their aircraft in Kitty Hawk, North Carolina.¹ Today, the aviation industry is still without the means to replenish ammo stores while airborne. November 1, 2016 marked the 105th anniversary of the first air-delivered explosives, which were dropped over the sands of Libya by Italian pilot Lieutenant Giulio Gavotti in 1911. Now is the time to make the possibility of mid-air rearming become a reality.

A major question regarding tomorrow's capabilities is, should the United States invest in the ability to rearm Unmanned Aerial Systems (UAS) while airborne? The two main considerations regarding this capability are technological feasibility and return on investment. The author believes that mid-air rearmament is within the realm of technical possibility, and that the battlefield benefits that this capability offers proves that it is worth the investment. Therefore, research and development of mid-air UAS rearmament should be undertaken immediately in order to endow the United States (US) with this ability for future conflicts. The author uses present technology, US Air Force (USAF) projections and hypothetical scenarios to promote the advancement of UAS mid-air rearming.

UAS armed-coverage is limited by weapons on-board, fuel, the human dimension and other operational factors such as structural or systems malfunction. The author's primary focus is on how UAS airborne rearming can marginalize, if not eliminate, the weapons limitation. This paper respects the other factors, however its focus is in the munitions arena. In today's environment, an armed UAS is relegated to perform only Intelligence Surveillance and Reconnaissance (ISR) related duties after its munitions have been expended and before it has the opportunity to land and reload. For example, if a MQ-9 Reaper is tasked to provide ten hours of

armed overwatch to a ground unit, but expends its ammunition within the first two hours, then it has lost its ability to kinetically, i.e. weapons impact, influence the battlefield for 80% of its assigned mission. In this scenario it is highly likely that the MQ-9 would remain on-station as an ISR asset, while additional aircraft are tasked to support the ground forces through Close Air Support (CAS) and possibly Air Interdiction (AI). However, if the UAS is rearmable then it can maintain its armed presence until one of the other limiting factors dictates its Return To Base (RTB). Within this scenario, mid-air rearmament would diminish the need for additional aircraft and permit such aircraft to conduct other missions elsewhere on the battlefield. Therefore, this capability becomes a force multiplier for the Joint Force Air Combat Commander (JFACC) by assisting them in maximizing the combat power of all assets under their control, while simultaneously becoming a force multiplier for ground commanders because of mid-air rearming's ability to provide continuous on-call fires.

On-call fires assist ground forces by reducing the time needed to kinetically affect enemy forces and by increasing flexibility on the battlefield. Rearmable UASs reduce the time needed to strike the enemy because of its persistent armed-coverage capability. This would negate the time required to task additional aircraft, await their arrival and afford flight crews time to gain battlefield awareness before engaging the enemy. In future engagements this may take hours because of aircraft affordability and vast transit distances. However, rearmable UASs could kinetically support the ground forces and only have to exit the battlefield to rearm and then return. If there was more than one UAS then the ground force could arguably never have a minute without armed support from above. This drastically increases flexibility for the ground commander. Rearmable UASs could mean the difference between friendly ground forces maintaining the offense rather than pausing and affording the enemy time to recover. It could

also mean not slowing an advance in order to give artillery batteries time to setup and fill the “on-call fires” void. Proof of this concept is discussed in later scenarios.

For the sake of this paper UAS facts and assumptions are required for further reading. It is a fact that the USAF foresees unmanned fleets replacing manned aircraft in many, if not all, mission sets. The USAF made this clear in the 2009 UAS Flight Plan, when it stated that its vision “is for a USAF where UAS are considered viable alternatives to a range of traditionally manned missions”.² This includes counterair, Suppression of Enemy Air Defenses (SEAD), Airborne Air Refueling (tanker not receiver), and many others.³ This is critical as it proves that the USAF foresees an unmanned fleet which is faster, more maneuverable and flies for longer durations (days and weeks) than any of today’s manned aircraft. Figure 1 is a table from the 2009 UAS Flight Plan, which showcases the “Potential sets of platform capabilities for UAS” with an associated timeline.⁴ The USAF’s UAS vision, and its subsequent path forward, is why the author chose to research rearming UASs instead of manned aircraft.

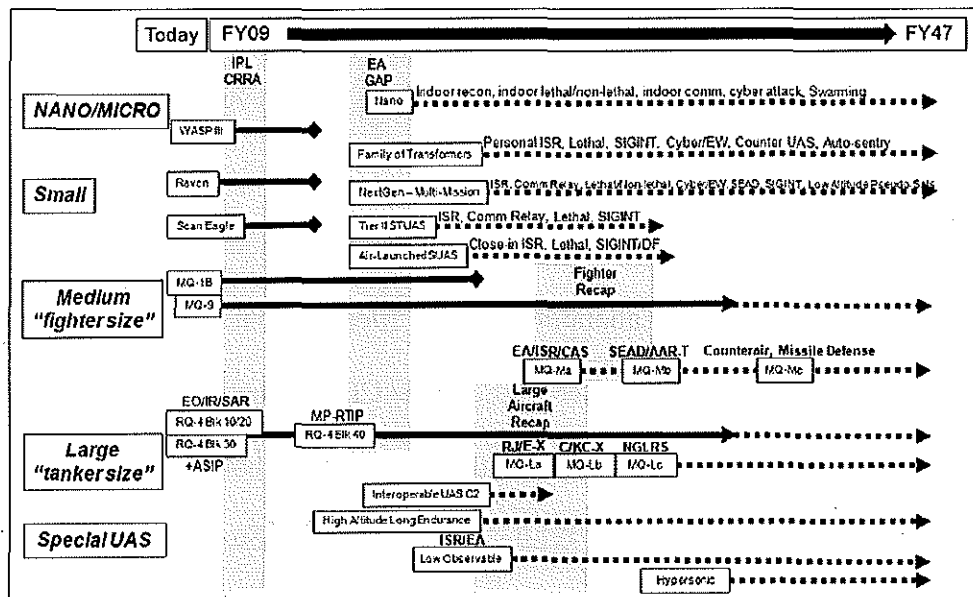


Figure 1

This paper's focus is on year 2032, fifteen years from the time of publishing. This time window is close enough to allow for accurate predictions based off of today's technology, while far enough to permit the acquisition process to make mid-air UAS rearming a reality. The author assumes that manned air-to-ground platforms will still outperform their UAS counterparts in terms of speed and maneuverability by 2032. However, by that time it is likely that strike capable UASs will approach, if not reach, supersonic speeds, while having the ability to outlast manned aircraft by a matter of days in terms of sortie duration. Boeing's Phantom Eye, which completed nine test flights but was discontinued in August 2016, offers a glimpse into where UAS technology is heading. The Phantom Eye was an armed UAS that was to remain airborne for four days and operate at altitudes of 60,000 feet.⁵ Even more impressive was Boeing's larger model which was to boast a sortie length of ten days and a 200% increase in payload.⁶ Northrop Grumman was simultaneously conducting test flights on its unmanned aircraft the X-47B, which is now under contract with the US Navy (USN). In April 2015, the X-47B became the first-ever unmanned aircraft to autonomously receive fuel from an airborne tanker.⁷ While airborne refueling advancements continue to enter the battlefield, the world has yet to even see a rearmable aircraft prototype.

No nation currently has a known mid-air rearming capability, but the idea has certainly been researched. The US Air Force Research Laboratory (AFRL) filed a patent for manned mid-air rearming in January 2005⁸, and it is not alone. According to the CEO of the Israeli-owned company Far Technologies, the US filed its patent two months after Far Technologies filed a patent for its Airborne Rearming System (ABRA)⁹. While the author is cautious about being labeled a "good idea fairy", the brainpower and expertise behind this paper pale in comparison to AFRL and its engineering know-how. The AFRL and Far Technologies examples prove to the

reader that some of the world's brightest minds are attacking the issue of mid-air rearming technology.

The obvious difference between this paper's concept and AFRL's patent application is that the author is arguing for unmanned rearming while AFRL's patent is for manned aircraft only. For the purposes of this paper, the author will adopt AFRL's model of a dissimilar aircraft rearming operations. This requires a large aircraft, comparable to a C-17, which will possess munitions bays used to store UAS receiver payloads. This airframe, known here as the "payload aircraft", will have the ability rearm different types of unmanned aircraft. This is in contrast to similar platform refueling operations, such as the US Navy's F-18-to-F-18 model. Assuming that midair rearming is possible within fifteen years, it is important to discuss possible payload aircraft flight profiles.

The payload aircraft will depart from its operational airbase and proceed to its established orbit, i.e. repeating flight path, within the Joint Operating Area (JOA). The orbit is positioned at a distance far enough away from enemy threats to permit a retrograde with a high probability of survival, while close enough to remain combat effective. The location of the orbit may require the allocation of external protection measures such as Defensive Counterair (DCA) resources. DCA sorties are often planned to protect other High Value Airborne Assets (HVAA) such as Airborne Warning and Control System (AWACS) and RIVET JOINT. The payload aircraft's orbit requires the use of a three-dimensional "block" of airspace that permits freedom of movement to accommodate for safety of flight for reasons such as weather, and operational needs like altering working altitudes to meet the performance requirements of different UAS aircraft types. The payload aircraft would normally stay within the confines of its assigned airspace and await the arrival of UASs requiring munitions.

When necessary, the rearmable UASs would depart their operational area and join the payload aircraft in its assigned airspace. The flight crews of both aircraft would then conduct the rearmament using established Tactics, Techniques, and Procedures. Post-rearming, the UAS would leave the payload aircraft's airspace and return to its previous working area or possibly transit to a different portion of the battlefield if it has been tasked to support a different mission. Dependent upon the risk level, the payload aircraft may depart its orbit and rearm the UAS closer to its working airspace in order to maximize UAS coverage time.

UASs inherently possess a lower risk level than manned aircraft. Lack of a flight crew onboard the aircraft increases the likelihood for UASs to operate independently throughout the battlespace, such as to and from the payload aircraft, without mutual support from a "wingman", which is desired, if not required, for manned aircraft. The lower risk tolerance of UASs is critical because it would allow unmanned aircraft to remain over the battlefield, rather than having to escort its wingman to the payload aircraft for safety of flight reasons. This means fewer pauses in combat operations and an increase in the likelihood of maintaining the offensive. There are also benefits outside of direct combat with which UAS mid-air rearming can assist.

The ability for UASs to takeoff without munitions onboard can have political impacts. Since the US tends to take the fight to the enemy, it requires the approval of foreign governments to use their land, coastal waters, and air for the projection of US power. These foreign governments often, if not always, place caveats and restrictions on what the US can and cannot do within their borders. The ability to takeoff without ammunition onboard UASs has the potential to remove at least two political barriers.

The first barrier is gaining approval for the placement of munitions within the borders of a foreign nation. The US experienced a situation such as this when a country neighboring

Afghanistan banned all US combat aircraft, yet allowed combat support aircraft to remain. Rearming while airborne also offers plausible deniability to the hosting government when facing domestic opposition towards supporting combat operations. The other barrier involves the politically sensitive area of armed over-flight permissions. Section 5 of AFRL's patent application specifically mentions how mid-air rearming can reduce the possible political friction normally experienced during armed over-flight and ammunition storage negotiations.¹⁰ Negating these diplomatic requirements provides flexibility to the strategic decision makers, while simultaneously impacting adversary intelligence gathering operations. Returning to base with munitions would certainly be just as politically sensitive, however this can be mitigated by establishing weapons release areas elsewhere within the JOA or by landing at a different location in order to offload the munitions prior to the aircraft returning to its original airfield.

A reduction in ground-based arming locations would hinder enemy intelligence collection operations and also alleviate friendly manning problems. The adversary's use of "spotters", persons who track and relay information concerning friendly flight operations, has been practiced for years. Mid-air rearming can assist in marginalizing spotter effects by minimizing the number of takeoffs and landings. This is in addition to having "clean wings", i.e. no munitions, when they are seen. Seemingly small efforts such as this can significantly hinder an adversary's collection efforts and add to their confusion.

A reduction in the number of airbases hosting munitions troops, those charged with the care and placement of payloads on aircraft, provides greater flexibility to the Commander of Air Force Forces (COMAFFOR). The COMAFFOR, the individual responsible for the placement and manning of all airmen within a theater, would theoretically possess the same number of munitions personnel, but can now increase the ammunition capabilities for those airbases which

will continue to conduct ground-based rearming. The COMAFFOR is concerned not only with manpower, but also the combat effectiveness of all USAF platforms within the JOA.

UAS flight performance increases, while fuel costs decrease, when permitted to takeoff at a lower weight. A reduction in weight at takeoff allows aircraft to climb and transit at faster speeds. This means faster response times to the combat area and longer loiter time due to the decrease in fuel consumption used to get there. Lighter takeoff weight also places less stress on the platform itself. The benefit of less stress on the structure, coupled with fewer takeoffs and landings, is likely to increase airframe life expectancy by a matter of years. Mid-air UAS rearmament obviously possesses many beneficial aspects; however there must be certain barriers that have hindered its advancement.

This paper acknowledges some of the possible limitations and roadblocks to creating rearmable UASs. One possibility is that there is no need for a rearming capability because the main limitation to extending armed-coverage is not munitions on board, but rather a restraint in the human dimension, fuel consumption or structural and systems factors. The author was unable to locate open source data that would show UAS combat mission profiles and their corresponding reasons for RTB. Though worthy of further research, the author feels that the requirement to land and rearm will be the primary limiting factor for future UASs since tomorrow's unmanned sorties are expected to be significantly longer than today's, thereby increasing the likelihood of munitions depletion due to time spent above the battlefield. For example, in today's counterinsurgency (COIN) environment, the probability of a MQ-9 expending munitions during a 20-hour sortie is relatively small. However, using Boeing's Phantom Eye's expected loiter time of ten days, the likelihood of kinetically engaging the enemy

goes up by 1200%. Even if one of the other factors limits the UAS to half its scheduled sortie length, the possibility of releasing weapons still increases by 600%.

Another possible reason not to pursue mid-air rearming is because of an absolute technological limitation that the author is unaware of. This may be the reason behind AFRL's patent application but lack of a known prototype. As stated previously, the author does not have the expertise to argue technical aspects with complete assurance, however an absolute technological barrier is unlikely to be a reason not to pursue this capability. The technological hurdles may be difficult, but if the financial means are available to permit engineers and scientists to conduct research and testing, then they are very likely to find a solution.

The most likely culprit working against the development of this technology is funding. The USAF allocates a significant portion of its budget to Research and Development (R&D), however it still has existing requirements, priorities, and commitments to uphold. Unexpected financial limitations, such as 2013's sequestration, and the infamously high cost overruns of the F-35 program, are proof that short and long-term budgets are not immune to modification. Mid-air rearming obviously requires money, however the author argues that this program be placed high on the USAF's list of product development.

Counterarguments to this program, though valid, should be overcome. This is because of the numerous benefits mid-air arming brings not just to the warfighter, but also to the politician. Mid-air rearming possesses the ability to drastically increase combat effectiveness of the Joint Force. This capability brings cascading effects that will prove to become a force multiplier for tomorrow's fight. Joint Publication 1-02 defines a force multiplier as a capability that, when added to and employed by a combat force, significantly increases the combat potential of that force and thus enhances the probability of successful mission accomplishment¹¹. The following

two examples will showcase how mid-air rearmable UASs will raise combat effectiveness and heighten the likelihood of battlefield success.

The year is 2032, and the US is in an armed conflict with near-peer competitor country X. It is day seven of the conflict, and the Joint Force can gain only localized air superiority. The Joint Force Commander (JFC) determines that now is the best time to put Boots On the Ground within country X, and subsequently tasks his troops to seize an airfield within X's borders. This operation is critical and will provide a lodgment for the future projection of air and ground combat power. The JFC has determined that this is the main effort and appropriately issues the order to his subordinate commanders.

This operation is a major muscle movement for the Joint Force Air Component Commander (JFACC). It requires stealth, mobility, counterair, Suppression of Enemy Air Defense (SEAD), Close Air Support (CAS), Air Interdiction (AI), ISR and Command and Control (C2) aircraft. Therefore, this operation requires the use of a Large Force Strike Package. The JFACC has successfully conducted Large Force Strike Packages since the conflict began; however, overtly placing friendly troops within enemy territory is both a responsibility and a liability. The responsibility to keep friendly ground troops safe requires an immense amount of air power when air superiority has yet to be achieved throughout the entire JOA. The JFACC is painfully aware that this operation will steal combat power from other reaches of the JOA. It is exactly this scenario where re-armed UASs can assist the JFACC in exploiting the successes of the operation while simultaneously allowing the JFACC to maintain commitments elsewhere.

F-22s lead the strike package by ensuring that enemy airborne aircraft are neutralized before ever becoming a threat to the strike package. Next, the B-2s and F-35s enter the battlespace to destroy the enemy's Integrated Air Defense System, Ground Control Radars, and

aircraft located at the airfield. The rest of the strike aircraft, to include eight rearmable UASs, soon follow and are overhead the target area to strike assigned targets and neutralize remaining threats before the vulnerable mobility package arrives for the airdrop.

Twenty minutes later the C-17s carrying a battalion of paratroopers arrives and conducts the airborne operation. The paratroopers successfully descend to the ground and begin to seize the airfield. By this point, the enemy is exclusively using small arms to provide resistance. All manned strike aircraft have released their munitions, expended their fuel, and now must RTB to rearm, swap crews, and prep for follow-on missions. However, the rearmable UASs, ISR and select counterair aircraft remain.

As planned, the four rearmable UASs withheld 50% of their munitions with the knowledge that they would provide CAS and/or AI to the ground forces after the rest of the package departed for home. The benefit of UASs maintaining armed-persistence cannot be overstated. Having this capability prevents the JFACC from having to task up to fifty or more sorties to the battalion over the course of the new few days. This allows the JFACC to service other priorities while knowing that the ground forces have 24/7 coverage. This is especially important after the execution of a major strike package where the large amount resources required will have a negative impact on the airpower capital available for subsequent missions.

The enemy anticipated such an attack and launched their counterattack after most of the friendly aircraft had departed. Friendly ground forces now face a coordinated enemy armed with Indirect Fire, Rocket Propelled Grenades, and small arms. The ground commander immediately requests CAS for support in beating the enemy back. The Battalion Joint Terminal Attack Controller (JTAC) establishes radio contact with the armed UASs and begins to execute the ground commander's guidance.

It is not long before ten Laser Guided Bombs are employed; however, the battlefield intensity has yet to diminish. By this time the UASs should be out of weapons because of the munitions they dropped during the initial strike package and because of their time spent conducting CAS. However, the UASs have continuously rearmed throughout the fight by visiting the payload aircraft. By alternating which aircraft depart the battlefield to rearm and which stay overhead of the battalion, the UASs have been able to provide continuous ISR and armed-coverage to the ground troops. This prevented any lapses in exposure and helped the ground forces defeat the enemy's counterattack.

By day two the fighting has calmed, but the possibility of air landing additional troops was negated by enemy sabotage on the runway during the initial phase of the operation. The four UASs maintained coverage and helped ground troops push the bridgehead out five miles beyond the airfield. In the afternoon an intelligence report signals that enemy forces will be positioning Multiple Rocket Launcher Systems (MRLS) thirty-five miles from the airfield after sundown. In conjunction with air superiority fighters and ISR assets, two of the UASs depart from their CAS mission in order to conduct AI strikes on the MRLSs prior to them being within range of the airfield. All of this takes places with little to no impact on the ground troops.

Unfortunately the buildup of friendly forces never happens and the ground commander adopts a defensive posture in anticipation of a brigade-level counterattack. Ground troops establish a strong-point defense around the airfield while the UASs provide CAS and AI when needed. For the past twenty-four hours the UAS operators, Air Liaison Officer, AOC personnel, ground commander, and the battalion staff have devised a defense plan.

On Day 3 of the operation, once the enemy's brigade is within fifty miles of the airfield, the UASs strike pre-planned targets along the enemy's axis of advance in order to halt its

encroachment. After dropping their munitions, the UASs immediately proceed to the payload aircraft, rearm and return to the battlefield to provide CAS. While the UASs are rearming, scheduled strike aircraft enter the battlespace and attack the paralyzed enemy brigade. This attack, facilitated by the rearmable UASs, removes the immediate threat to friendly forces at the airfield and affords the commander time to build combat power.

The rearming capability of the UASs proved to be a force multiplier for the Joint Force in this scenario. The UASs assisted in defeating both counterattacks, enhanced the JFACC's ability to spread combat power throughout the JOA and provided continuous armed-coverage for three days. The utility of mid-air rearming during conventional warfare is obvious, but how will it hold up in a COIN environment?

The JFC has determined that after two months of combat operations with Country X, it is time to transition to Phase IV, Stability Operations. Joint Publication 5-0 describes Phase IV as the phase where there is no functioning civil governing authority, and where the Joint Force may be required to conduct limited duties normally associated with governance along with other agencies and partners¹². Phase IV encompasses the vast majority of the most recent military campaigns in Afghanistan and Iraq since 2001 and 2003 respectively.

In this example an Army company is tasked to visit the villages within its Area of Operation and conduct meetings with power brokers in regards to the restoration of electricity and running water, which were damaged during combat. This operation is expected to take three days and the Company Commander appropriately files an Air Support Request for continuous ISR and armed over watch from the air component. The Air Operations Center (AOC) fulfills this request with the allocation of two armed UASs who will support the ground commander throughout the operation.

On the second day, while enroute from one outlying village to another, the company's convoy was ambushed. An Improvised Explosive Device destroyed the leading vehicle and has created a bottleneck, which the enemy is exploiting by attacking the stagnated convoy. While the troops respond accordingly, the UASs are used to provide ISR. The JTAC is communicating with the UAS operators to build an accurate picture of the battlefield and to engage the enemy when necessary.

The ground commander asks the JTAC to neutralize the enemy's heavy machinegun using the UASs. This is accomplished and the JTAC continues to conduct CAS to eliminate the most dangerous and closest threats. Heavy fighting continues past the first hour, however friendly forces are in better defended positions and the initiative has now swung in favor of US forces. Both UASs have expended their kinetic payloads and now solely provide ISR to the ground troops. It is at this time that an intelligence source discovers that a group of 15-20 armed, middle-aged men are boarding trucks in a nearby village in order to join the fight alongside the enemy.

The JTAC request additional CAS support, but is told that it will take two hours to arrive. This is where the rearming capability of the UASs becomes a force multiplier. With the ground commander gaining more and more control of his immediate surroundings, he asks that ISR be placed on the staging threat in the nearby village. The decision is made to split the UASs. One UAS will place its sensors on the expected threat while the other visits the payload aircraft to rearm.

The UAS spots the armed group and their five vehicles just prior to them departing for the fight. While overhead, the UAS builds the target package and relays all information to the ground commander, as well as the UAS being rearmed. After restoring its payload, the rearmed

UAS departs immediately to neutralize the armed group. The ISR gathering UAS begins to “buddy lase” the targets in order for its wingman to destroy the vehicles. The first vehicle is struck and the convoy grinds to a halt. The enemy combatants pile out of the remaining vehicles while UASs work to render them combat ineffective. Though 80% of the combatants and 20% of the vehicles survive, the threat to friendly forces has been removed. The ground commander can now maintain the initiative and continue to attack the enemy without fear of the adversary being reinforced.

With the threat now neutralized, the ground commander can either request for one or both UASs to return overhead in order to provide ISR or for both of them to rearm and return. The commander ultimately decides that both UASs will restore their payloads and then reenter the fight. The first UAS rearms and precedes overhead friendly forces within 25 minutes where it provides ISR, CAS and builds the ground picture for its wingman that will join ten minutes later. Ultimately the UASs drop 50% of their remaining munitions and assist the ground forces in attaining victory within five hours. However, the benefits of rearmable aircraft do not stop there. The two UASs can again rearm and provide persistent ISR and armed over watch for the remaining day and half of the operation.

What cannot go without stating, are the beneficial secondary and tertiary effects felt throughout the rest of the JOA. In this scenario, the rearming capability of the UASs permitted other airborne assets, and ground alert aircraft, to carryout their assigned missions instead of being re-tasked to support the company mentioned. If the UASs were not rearmable then it would be impossible for those aircraft to provide continuous armed-coverage for the remaining 36 hours. If the ground forces had encountered additional fighting, and the UASs were not rearmable, then it could easily be expected that somewhere between two and ten CAS aircraft

would be required for the rest of the operation. The number of additional aircraft would depend upon the frequency, intensity and length of additional fighting. Even in this scenario, armed-coverage would be intermittent and likely only during times of combat, due to the limited number of aircraft and competing priorities throughout the JOA.

The arguments for developing the capability to rearm UASs mid-air are robust. At the strategic level, it may expand the number of foreign nations that allow American UASs to operate from their borders because it removes the political barrier of “armed” aircraft. At the operational level it provides a very effective means for the JFACC to maximize the air component’s combat power throughout the entire theater. And finally, it supports troops at the tactical level because it delivers weeks of persistent armed-coverage, and on-call fires, which will enable them to fight and win. Mid-air rearming’s unique ability to affect all three levels of war proves that the US should invest its time, money and resources into developing this combat force multiplier.

¹ Wallwork, Ellery D. *Flight of the Question Mark*, USAF Expeditionary Center, December 17, 2008, <http://www.expeditionarycenter.af.mil/News/Features/Display/Article/439168/flight-of-the-question-mark>.

² HQAF, USAF, *UAS Flight Plan 2009-2047* (Washington DC, 2009), p. 15.

³ *Ibid.*, 34.

⁴ *Ibid.*

⁵ Jennings, Gareth, *Boeing’s Phantom Eye to be Museum Exhibit*, *Janes*, August 30, 2016, <http://www.janes.com/article/63289/boeing-s-phantom-eye-to-be-museum-exhibit>.

⁶ *Ibid.*

⁷ Northrop Grumman, *X-47B UCAS Makes Aviation History...Again! (2015)*, <http://www.northropgrumman.com/Capabilities/X47BUCAS/Pages/default.aspx>.

⁸ Beyerle, John A. *United States Patent Application: 11052173 - Method For Aerial Rearmament of Aircraft*, January 31, 2005.

⁹ Iddo, Genuth, *ABRAcadabra, The Future of Things*, last modified September 11, 2016, accessed November 15, 2016, <http://thefutureofthings.com/3023-abracadabra-airborne-rearming>.

¹⁰ Beyerle, *US Patent 1105217*, Section 5.

¹¹ Joint Staff, *Joint Publication 1-02 Department of Defense Dictionary of Military and Associated Terms* (Washington DC, 2001), p. 185.

¹² Joint Staff, *Joint Publication 5-0; Joint Operation Planning* (Washington DC, 2011), p. xxiv.

¹³ Air Force Doctrine Document, *Chapter 5-The Tenets of Airpower*, vol. 1, “Basic Doctrine”, (Air University Press, AL, 2015)

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