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**The Continued Need for USAF Light Attack post-OEF/OIF:
A Survey of West African Infrastructure to Support Tactical Air
Operations**

by

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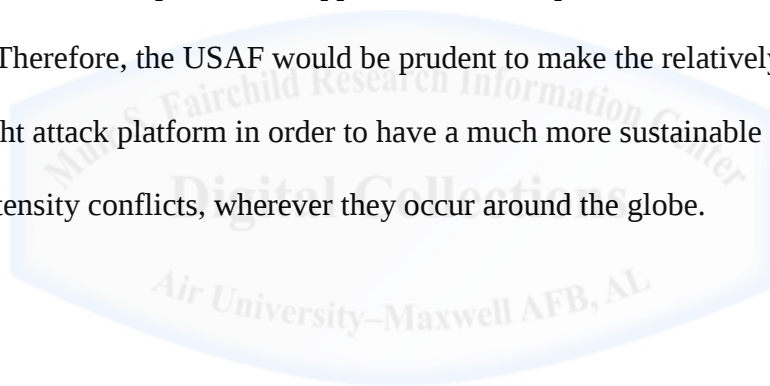
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Abstract

As the USAF transitions to post-OIF/OEF operations there is a continued need for a light attack platform to augment legacy fighter assets. The growth of transnational terrorism in West Africa significantly increases the likelihood that the USAF will be called to support tactical operations in this area. This research examines the infrastructure in West Africa to highlight how difficult high performance fighter operations will be in that area based on the limited number of well-established airfields and the logistical constraints imposed by those country's transportation systems. West Africa is by no means the only area of the globe where infrastructure would be hard pressed to support tactical air operations with the USAF's current force structure. Therefore, the USAF would be prudent to make the relatively small investment required for a light attack platform in order to have a much more sustainable and capable force for future low intensity conflicts, wherever they occur around the globe.



For almost half a decade elements in the USAF have been working to get a cost effective light attack aircraft into the inventory.¹ Proponents of the OA-X program have argued that such an aircraft would be just as capable of supporting ground operations in a low threat environment as high performance aircraft, but at a fraction of the cost.² Additionally, supporters of the light attack concept point to the increased basing options available to a force operating aircraft other than high performance fighters.³ In the wake of 'sequestration' and the looming 'fiscal cliff', few would argue that the Air Force's budget outlook is good.⁴ Operational budget and basing considerations are not going away any time soon. It is important to realize that with operations in Iraq complete, and Afghanistan winding down the need for a light attack alternative to legacy fighters has not waned. On the contrary, a survey of current and future hot spots in the fight against Al Qaeda and trans-national Islamic militants in Africa shows that basing restrictions and logistical considerations strongly support the need to include light attack aircraft in the USAF force structure.

The leading proponent of Islamic extremism in Western and Northern Africa is the group Al Qaeda in the Islamic Maghreb (AQIM). AQIM was originally a local Algerian Islamic movement intent on removing secular influence from the Algerian government. The group rebranded and began calling itself AQIM in 2006 when Al Qaeda's second in command acknowledged their links to the terrorist organization. Since then AQIM's area of operation has expanded beyond Algeria to include Mali, Mauritania, Tunisia and Morocco.⁵ AQIM also operates along the western boarder of Niger and may have links there to the local Tuareg group Mouvement des Nigériens pour la Justice.⁶ In 2010 AQIM announced its intention to foster links with the Nigerian Islamist group Boko Haram and offered to assist in training fighters for Boko Haram.⁷ AQIM aided ethnic Tuareg rebels in a March 2012 rebellion that seized much of

the eastern portion of Mali from government control. Since that time however, AQIM has taken control of much of the rebel territory and implemented strict Sharia law. Clearly AQIM is a threat to the regional stability in the Sahel and Maghreb.

The US does not want Al Qaeda or affiliated organizations to find new safe havens following the pressure being brought against Al Qaeda in Afghanistan and the Middle East. The US National Security Strategy from May 2010 specifically addresses US intentions to thwart Al Qaeda's attempts to find safe haven in the Sahel and Maghreb regions of Africa.⁸ Should AQIM find safe haven in this area they may be able to launch attacks into Europe and North America. Up until this point, European authorities have thwarted several AQIM plots in Europe. With a safe haven, either in eastern Mali or southern Algeria, AQIM may have a better chance of successfully launching international terrorist attacks. Finally, the attack on the US embassy in Benghazi highlights why the US needs to be concerned with AQIM and its expanding influence in Northern and Western Africa.⁹

The US is already working in this area of Africa. The US lead Trans-Sahara Counterterrorism Partnership is a US interagency effort that began in 2005. This partnership works with several of the countries in the Sahel and Maghreb.¹⁰ These nations also see the threat from AQIM and are working together to confront it. In September 2010 Algeria, Mali, Mauritania and Niger announced plans for a joint intelligence center to counter AQIM.¹¹ The United Nations Security Council has called for Mali, the African Union and Economic Community of West African States (ECOWAS), to formulate a military plan to retake eastern Mali from AQIM.¹² It is clear that the region, the world and the US are taking the threat posed by AQIM seriously.

While France and USAFRICOM have both ruled out the use of US military intervention at this point, there is no reason to completely discount the possibility or utility of using light attack aircraft to support local military efforts. There is almost no question that conventional US ground troops will not be used to counter AQIM. US domestic politics and economic considerations prevent that from being an option. Additionally, due to the colonial history in Africa, there is little desire from the local people or governments to see Western military forces on the ground. However, this should not automatically preclude the use of US airpower to assist local forces. The relatively small footprint airpower requires compared to the support it can provide indigenous forces should not be overlooked. The US experience with Rustic Airborne Forward Air Controllers in Cambodia decisively demonstrates that US airpower can be effective supporting indigenous armed forces, even without any US presence on the ground.¹³

Current USAF assets however prevent US airpower from being an attractive option for the struggle against AQIM. The USAF force structure, as employed in OEF and OIF would not work in the Sahel and Maghreb for several reasons. The simple fact that high performance fighters like the A-10, F-16 and F-15E require substantial airfields to operate from severely restricts their usefulness in this region of Africa. Additionally, moving the massive amount of fuel these assets consume requires a much stronger logistic capability than the decrepit rail and road systems provide in most of these African nations. The minimal field requirements as well as relatively minute logistic requirements of light attack aircraft make them ideally suited to support indigenous operations against AQIM in Mali, Mauritania, Niger, Nigeria and Algeria.

There are wide varieties of issues military planners must confront when deciding on where to base air assets: the location and dimensions of the airfield, its proximity to other logistics networks, and local weather are just a few. One of the foremost considerations for

basing high performance aircraft is runway length. Immediately a large number of bases can be eliminated from a list of possible operating locations simply because the runway is insufficiently long for certain aircraft to use.

Take-offs from shorter runways require reduced combat loads, thereby reducing the overall effectiveness of a combat aircraft. Additionally, safety margins for engine malfunctions on take-off, whether the aircraft continues or aborts the take-off, shrink as runway length decreases. Minimal safety margins can be accepted for short durations during periods of high intensity conflict; but during low intensity conflict, safety concerns will probably outweigh most other operational needs with respect to take-off and landing distances. Specific performance data for combat aircraft are not available in the public domain. However, by reviewing USAF operations during the low intensity portions of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) it is possible to discern basing patterns.

Looking over the past decade a clear pattern emerges; US fighter assets do not operate out of airfields with runways much shorter than 10,000 feet for sustained low intensity operations. Throughout OEF and OIF, USAF fighters operated out of five main airfields; Al Udeid Air Base (AB), Al Asad AB, Balad AB, Bagram AB and Kandahar AB. Al Udeid AB in Qatar has been a major fighter base for OEF and OIF since F-15Es arrived in January 2003.¹⁴ The runway at Al Udeid is 12,300 feet long. A-10 aircraft operated out of Al Asad AB, Iraq in 2007.¹⁵ Al Asad has two runways. The short runway is 13,000 feet long while the long runway is 14,000 feet.¹⁶ F-16 fighters were stationed at Balad AB, Iraq until they were pulled out at the end of 2011.¹⁷ Balad AB has two runways, both 11,000 feet long.¹⁸ Looking at these three airbases gives a general idea of the size of runways the USAF prefers to operate out of for prolonged periods during low intensity conflict. However, the previous cases really do not set

the lower limit for acceptable runway length, it is possible that other factors drove the USAF to base assets at fields that just happened to have long runways.

Studying the major USAF fighter bases in Afghanistan however, provides strong evidence of the runway limitations for F-15E and F-16 fighters. The original runway at Bagram AB was 9,850 feet long.¹⁹ A-10 aircraft operated off of this runway from the early days of OEF.²⁰ F-15E aircraft did not begin operating from Bagram AB until January 2007.²¹ This was immediately after a major construction project to build a longer runway at Bagram AB was complete in December 2006. The USAF spent 68 million dollars to build a new 11,800 foot long runway.^{22,23} The situation at Kandahar AB was similar to at Bagram AB. F-16s, in this case from the Netherlands, did not begin operating from Kandahar AB until late 2006.^{24,25} At the beginning of OEF, Kandahar AB only had about 7,200 feet of usable runway.²⁶ The 35 million dollar project to lengthen the usable runway to 10,500 was completed in early November 2006.²⁷

Using US and NATO experience in OEF and OIF one can draw conclusions about runway limitations for high performance fighter aircraft in a low intensity conflict. A-10 aircraft can routinely base out of airfields with just under 10,000 foot runways. F-16 and F-15Es on the other hand did not operate out of runways shorter than 10,500 feet. How do these figures compare to the stated performance requirements for a light attack aircraft?

The exact type of aircraft selected to fill the light attack role is inconsequential to this research, but a review of two possible programs gives a clear sense of likely performance requirements. The OA-X program specified the aircraft be capable of operating from any 3,000 foot runway that a C-130 could also use.²⁸ Currently there is interest in using an MC-27J to fulfill a variety of light attack and transport capabilities.²⁹ The MC-27J could be configured with various roll-on roll-off pallets to operate as a fires or transport platform as mission dictates.³⁰

The C-27J boasts a ground roll for maximum weight take-off from an unprepared surface as just under 2,000 feet. Landing distances for a maximum weight landing are listed at just over 1,100 feet.³¹ Regardless of the type of aircraft eventually selected to perform air support in future low intensity conflicts there is little doubt that the runway requirements for that aircraft will be substantially less than for the current fleet of USAF fighter aircraft. For the purposes of this research light attack aircraft will be assumed to be capable of operating from prepared or unprepared runways as short as 3,000 feet.

Many of the countries the US could be operating in over the next decade do not have sufficient airfields to support sustained operations by high performance fighters such as the F-15E, F-16 and to a lesser extent the A-10. A review of the available airfields in Mali, Mauritania, Niger, Nigeria and Algeria demonstrate how useful a light attack aircraft would be in the USAF inventory due to the lack of suitable airfield for current fighters. Airfield data was culled from a number of open sources including Jeppesen aviation products, Janes publications and the CIA World Factbook. The complete data set is displayed in Appendix A. Any airfield with a paved runway longer than 10,500 feet was deemed suitable for use by all fighters. Those airfields are represented on the country maps with an F-16 silhouette. If an airfield had a paved runway longer than 9,800 feet but shorter than 10,500 feet it was categorized as suitable for A-10s and light attack. These airfields are shown using an A-10 silhouette. Any field with prepared or unprepared runways shorter than 9,800, down to 3,000 feet, was categorized as usable only by light attack aircraft. The silhouette of a small propeller airplane identifies the locations of these airfields.

Each airfield on the following maps includes a range circle depicting the distance of a 15 minute flight. For the A-10 and light attack a cruise speed of 300 KTAS was used to calculate

this ring. For the F-16/F-15E airfields, 480 KTAS was used to calculate the ring. Fifteen minutes cruise time to and from an area provided a good balance between reaction time and effective time on station. While a 15 minute reaction time may be too slow to respond to a small scale troops in contact situation, it is a reasonable amount of time to allow for reaction to emerging targets or developing tactical situations. Some discussions have used a 10 minute reaction time as a barometer for success.³² However, that time frame is more applicable to the smaller areas involved in both Iraq and Afghanistan and the preponderance of assets allocated to those fights. In Western Africa the distances preclude such short reaction time, so a reasonable expectation for airpower is the ability to arrive at tactically critical areas within 15 minutes.

Additionally, by allowing for half an hour of transit time per mission (15 minutes each way) this research also assumes a tactically useful amount of on station time ranging from over 1 hour for the F-16s to 4 hours for the AO-X. The A-10 and F-15E would be somewhere in between these extremes for on station time. This precludes the requirement for tanker support. In low intensity conflicts the use of tanker assets to increase on station time is more of a cost multiplier than a force multiplier. The added fuel and resources required to set up a tanker base somewhere near the theater and then fly the tankers to the operational area significantly unbalance the equation for this discussion. While it is possible to place fighters anywhere in the world with enough tanker support, the question must be asked; “is that the best bang for the buck?” To avoid an overly complicated discussion it is sufficient to conclude that if operations are logistically cheaper and easier to accomplish for light attack aircraft as opposed to legacy fighters without tanker support, then the equation can only tip even further in favor of light attack when addition tanker support is factored in for the legacy fighters.

The country of Mauritania is situated on the West coast of Africa, south of Morocco. For size comparison, Afghanistan is not quite two-thirds the size of Mauritania. The two countries have similar dimensions north to south and east to west, but Mauritania is broader, so it has more area. Mauritania does not have a single airfield with a runway longer than 10,000 feet to accommodate F-16 or F-15E fighters. Mauritania's two main airfields, at Nouakchott and Atar, have 9,800 foot runways that A-10s could operate from. In addition to those airfields, Mauritania has ten other significant airfields, with runways ranging from 3,500 feet to 8,200 feet, shown on Figure 1. All but three of the additional ten airfields have paved runways.

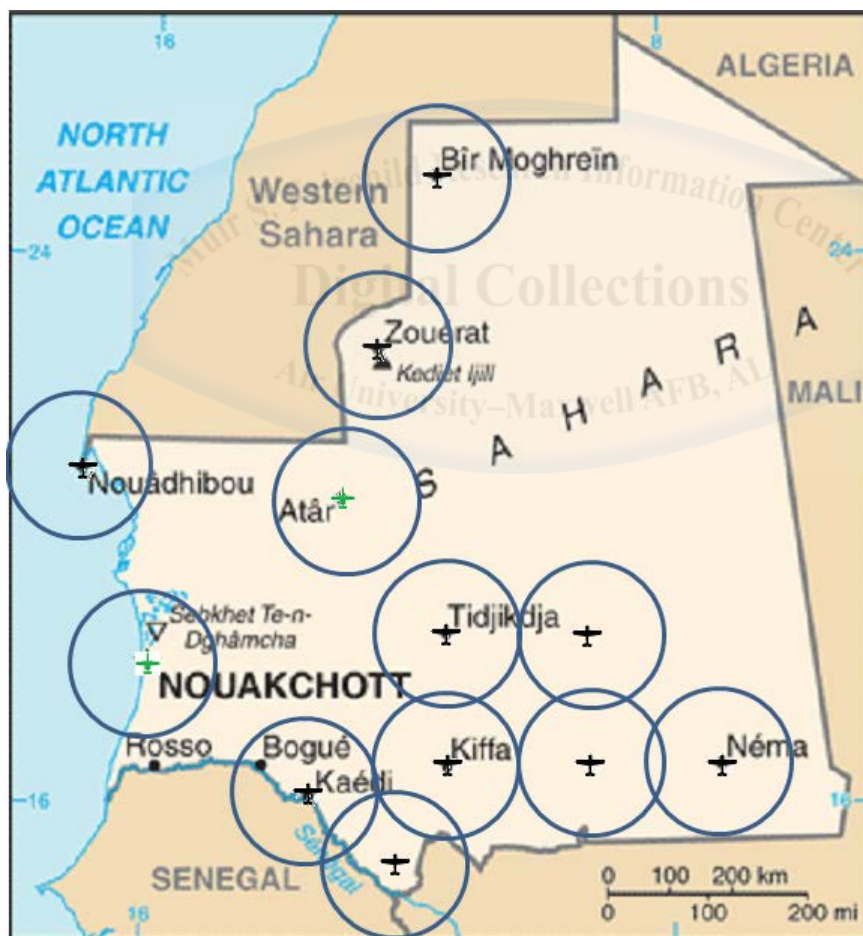


Figure1. Mauritania

The CIA World Fact Book indicates that besides the airfields shown in Figure 1, the country has another 15 unpaved airstrips. Most of the towns in Mauritania have a small airstrip. Of the 15 unpaved airstrips, only two are unusable for sustained light attack operations because they are less than 3,000 feet long. The remaining 13 range from 3,000 to 8,000 feet long and could be used for light attack operations.

Clearly there is a need for light attack aircraft in order to successfully employ airpower in Mauritania. The only two airfields that can employ current USAF fighters are situated well away from where AQIM is operating, along the border with Algeria and Mali. The easternmost airfield that can support A-10 operations is 500-600 miles from the eastern border areas. Without tanker support, current USAF fighters cannot operate over such great distances. It is no surprise that Mauritanian airfields would be better suited to light attack aircraft than high performance fighters. Mauritania's Air Force has Embraer Tucano and Aeromacchi Warrior light attack aircraft, but no high performance fighters.

With the addition of light attack, the USAF would have the capability to base out of numerous fields much closer to the action. In the southeast corner of Mauritania there are five airstrips that could accommodate light attack aircraft. Aircraft based out of Nema, Kiffa, Tidjikdja, and the two bases between, could cover the roads that lead to what had until recently been AQIM occupied northern Mali. Mauritania's main north-south running road passes through Atar, Zouerat and Bir Moghrein on the way to Algeria. Without the use of the bases at Zouerat and Bir Moghrein the highway runs almost 400 miles beyond extended duration air support from Atar.

With the legacy platforms currently available, the USAF could provide air support with reasonable loiter time to approximately 2.5 percent of the 1,030,000 km² of Mauritanian

territory. Using the available main airstrips for light attack aircraft, sustained coverage could increase over six-fold to 15.4 percent of the country. The addition of light attack aircraft to the equation is even more pronounced than these number indicate however, because the areas where AQIM is active are the areas that will see the majority of additional coverage from light attack.

Mali has nine airfields with paved surfaces. Of these only one is suitable for F-16/F-15E operations, Bamako-Senou International in the capital. The rest of the prepared surface runways are between 8,800 feet and 5,200 feet long. Besides the main airfields shown in Figure 2,



Figure 2. Mali

Mali has 13 additional unpaved airfields with runways longer than 3,000 feet. Without light attack aircraft the USAF would be extremely restricted when operating in Mali. The

northeastern section of Mali had fallen to AQIM aligned rebels, and is only now in the process of being reclaimed by a coalition of French and African nation forces. So the primary area for counter AQIM operations is at closest 400 miles from where current USAF assets could base. Light attack aircraft on the other hand can operate from bases much closer to the northeast. Additionally, as government forces have retaken the northeast, more airfields have become available to operate out of with light attack aircraft.

The French experience in January through March of 2013 is very informative as to the limitations high performance fighters face operating in this part of the world. The French led coalition started combat operations against AQIM in January 2013 to recapture northern Mali. During these operations, French forces have used fighter aircraft and helicopters for strike and close air support missions. The French Air Force employed Mirage 2000D and Rafale fighters, along with Mirage F1CD reconnaissance fighters. Six Mirage 2000D fighters operated out of Bamako-Senou International in Mali. Six of France's newest fighter, the Rafale, operated out of the long established base at N'djamena in Chad. The two Mirage F1CD reconnaissance fighters also flew from N'djamena.³³ French military news releases indicated that strike/close air support sorties averaged around 7-10 sorties per day throughout the operation but peaked at 20 per day in the last week of February.³⁴ A good number of the airstrikes took place in the vicinity of Goa and Tessalit. Tessalit is the airfield in the northeast of Mali, along the border with Algeria. Goa is 1,050 miles from N'djamena and 600 miles from Bamako. At such great ranges these operations required tanker support to execute. In order to support operations for 14 fighters France deployed four tankers.³⁵ A 1 to 3.5 tanker-to-fighter ratio is fairly high for combat operations and certainly increases the costs of the operation.

In early February, France air-dropped engineering equipment in Tessalit to reopen the runway by removing dirt piles the insurgents had used to block it.³⁶ Once this was accomplished, light attack aircraft could have operated from Tessalit as well as transports. By the end of February French ground forces were centered in Gao and Tessalit.³⁷ By operating out of these airfields, instead of major airports 600 to 1,000 miles away, the ground forces could have had improved cooperation and coordination with their air support. Additionally, even though a light attack aircraft would be slower than high performance fighters, being based at the fight rather than 1000 miles away completely negates the speed advantage for fast jets. Light attack aircraft operating out of the airfields in Gao and Tessalit could have provided the same quality of air support, probably for a longer duration with quicker reaction at a fraction of the cost.

Niger has seven airfields with paved runways. None of the bases can support F-16 or F-15E operations. Only two of the bases can support A-10s. Without the addition of light attack aircraft to the USAF inventory, only two bases in the whole country would be able to support fighters. In addition to seven paved runways shown in Figure 3, Niger has 18 unpaved airfields that can significantly increase coverage from a light attack platform.

Niger is almost twice the size of Afghanistan and is nearly 1,000 miles from east to west. Aircraft operating from only two bases would not be useful to provide timely or enduring air support for operations in such a large country. The range rings depicted around Niamey and Agadez only cover 2.8 percent of the country. Adding light attack to the equation significantly improves US capabilities in Niger. In addition to simply covering more of the country, light attack would cover important areas in the fight against transnational Islamic terrorism in Africa. Four of the airfields that only light attack aircraft can operate from are located along Niger's



Figure 3. Niger

southern border with Nigeria. Since Boko Haram is active in northern Nigeria this border is critical to communications between AQIM and Boko Haram. With light attack aircraft operating out of shorter airfields most of the Niger-Nigerian border can be covered easily. Additionally, the use of Dirkou (the light attack capable airfield in northeast Niger) helps get airpower involved in efforts to stem the flow of weapons from Libya into AQIM hands in Mali and Boko Haram hands in Nigeria.

Just like the situation in Mauritania, Niger's Air Force does not operate jet fighters. They rely on Mi-24D helicopters for attack missions and operate Diamond DA42 Guardians and Humbert Tetras light aircraft for observation and surveillance missions.³⁸ Niger does not

currently have the facilities to support jet fighter operations. However, it does have the capabilities to support light aircraft. If the USAF wanted to begin operations in Niger, light attack would require substantially less, if any, infrastructure upgrades to get operations up and running than operations with legacy fighters. This would mean operations could begin much more rapidly with a much lower outlay of resources.

Nigeria has 18 paved surface airfields listed with Jeppesen. Those fields are identified in Figure 4. Of those 18, eight are long enough to support fast jet operations, six can support A-10 operations and four can support light attack operations only. According to the CIA World Factbook, Nigeria has 37 paved runways over 3,000 feet.³⁹ This means there are probably

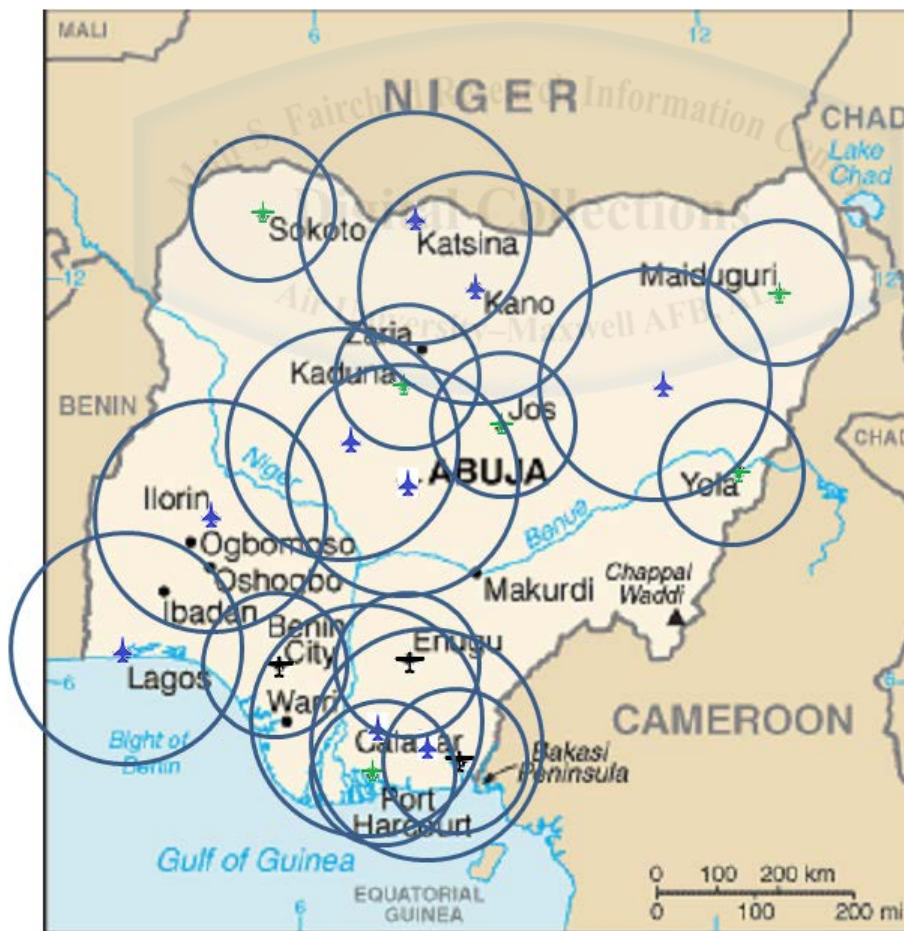


Figure 4. Nigeria

another 19 paved airfields that could support light attack operations. There are an additional 11 unpaved runways over 3,000 feet. Of all the countries in this survey, Nigeria has the best environment to operate current USAF fighters. There are a good number of long runways and they are spread around the country to provide coverage from the north all the way to the south and from east to west.

The airfields at Sokoto and Maiduguri cannot support F-16/F-15E operations, but those important airfields provide complete air coverage for the critical Niger-Nigerian border. Additionally, based on Figure 4 there is a coverage gap in the middle of the eastern portion of the country. The city of Makurdi has an international airport according to Janes.⁴⁰ It is quite likely that light attack aircraft could operate from Makurdi, therefore increasing the air coverage above and beyond what is shown in Figure 4. Additionally, the numerous paved and unpaved airfields discussed in the CIA World Factbook would undoubtedly provide light attack aircraft with very flexible basing options. This would give a force operating light attack aircraft increased opportunities to cooperate with local forces during air-ground operations compared to fast jet fighters, restricted by limited basing options.

Nigeria is the smallest of the countries surveyed here. It has an area of just over 900,000 km². For comparison Afghanistan is about two-thirds the size of Nigeria. However, Nigeria has twice as many 10,000+ foot airfields and operates Chinese F-7 fighters, so infrastructure for jet fighters is already in place.^{41,42} Air operations in Nigeria would not be significantly different from what the US and NATO have become accustomed to in OEF. Even so, light attack aircraft would still increase basing options and improve air operations for a force supporting Nigerian efforts to combat Islamist extremism either from Boko Haram or from the spread of AQIM.

By far, Algeria has the largest number of substantial airfields of all the countries surveyed here. Jeppesen lists 32 paved surface airfields in the country, all of which are displayed in Figure 5. While only five of these airfields can support F-16/F-15E fighters, the vast majority of them can at least support A-10 operations. This is due to fact that many of these airfields were built to support French jet fighters during the 1960s. The CIA World Factbook indicates that there are a total of 59 paved surface airfields over 3000 feet long with another 59 unpaved airfields over 3000 feet long. So there are an additional 86 airfields in Algeria that are not presented on Figure 5 which light attack aircraft can operate from.

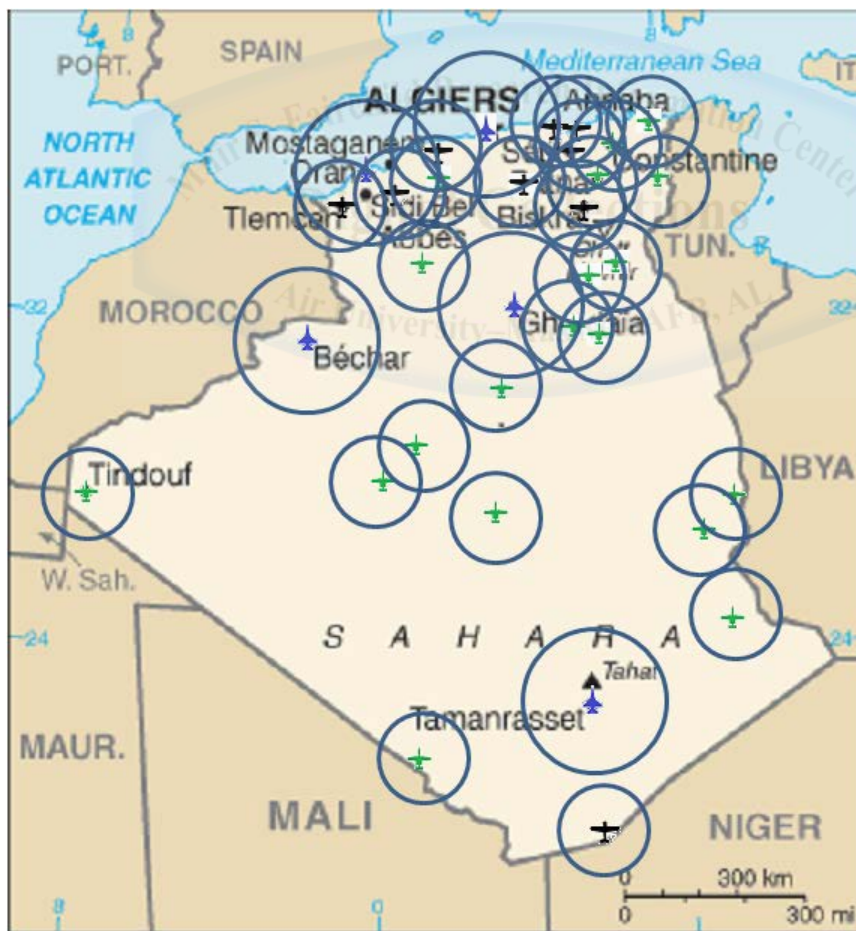


Figure 5. Algeria

Algeria currently employs several Su-30 Flanker variants and well as MiG-29, MiG-25 and Su-24 fighters.⁴³ The infrastructure to operate high performance fighters from some bases in Algeria is certainly there. However, Algeria is a massive country. At 2.3 million km² it is roughly 3.5 times the size of Texas and is the tenth largest nation in the world. Overlaying the country onto the United States, if the southern tip of Algeria was located at the southern tip of Texas, the northern coast would be along the South Dakota-Nebraska border. Meanwhile the eastern border would be in Mississippi while the western border would be in the middle of Arizona. The increased number of airports compared to some of the other countries surveyed is somewhat offset by the fact the Algeria is almost four times the size of Afghanistan.

Another factor that can be discerned from Figure 5 is that most of the airfields are located in the populous northern region. South of Bechar there is only one airfield that can support fast jet operations, Tamanrasset. Tamanrasset covers the intersection of the main north-south road running into Niger and a major road running to the east into Libya. However, the airfield is located nearly 300 miles from the actual border areas and would not provide rapid or enduring coverage for ground operations in those areas without tanker support.

In contrast there are two airfields located directly at the border crossing points on the southern border of Algeria that can support either A-10 or light attack operations. Light attack aircraft could operate out of both of these fields providing low cost, persistent air support for interdiction operations against AQIM and Tuareg cooperation in eastern Mali and northwestern Niger. The airfield at Tindouf similarly provides air coverage for operations around the border crossing point with Mauritania on Algeria's southwestern frontier.

The border with Libya has become a focus point since the January 2013 attack on the Amenas gas complex by Islamic militants. The lack of government control in southern Libya

has allowed several Islamic militant training camps to operate there with impunity. It is believed that militants from these camps crossed into Algeria to accomplish the attack on the gas complex.⁴⁴ There are three airfields along the Algerian-Libyan border where A-10s or light attack aircraft could operate from to help interdict militant operations originating from camps in Libya. Overall using light attack aircraft would significantly improve the availability of air support in southern Algeria. There are 11 bases in the southern half of the country where most operations would take place against AQIM. Fast jets can only operate out of one of these bases, but light attack in can operate out of all 11.

Airfields are not the only infrastructure to consider when evaluating an area for combat air operations. Air operations, especially using high performance jet fighters, require a substantial amount of fuel that has to be transported to the airfields somehow. While air transport is possible, ground transportation is by far the most economical way to transport fuel. It has been estimated that about half of the tonnage moved overland during OIF and OEF was fuel.⁴⁵ As such, it is imperative to assess the capabilities of the transportation systems of these African countries to determine if they will impede air operations.

Again, operations in Afghanistan provide an example of low intensity operations carried out over an extended time period. So many supplies, fuel and otherwise, arrived in Afghanistan via land routes from Pakistan that a US official expressed concern that a two-month closure of the border in 2011 could result in “a megacrisis” for NATO military operations.⁴⁶ Another concern regarding logistics in Afghanistan was the relative lack of roads for a country its size. Not only that, but Afghanistan had no rail system and was completely land locked. How do the countries surveyed in Africa compare with Afghanistan, which has been a logistical challenge for US forces, when it comes to infrastructure?

Mauritania, Mali and Niger are all even worse off than Afghanistan when it comes to infrastructure. While Mauritania is not land locked like Afghanistan, both Mali and Niger are. All three of these countries have GDPs ranging from one-half to one-quarter of Afghanistan, so there is even less money for road or rail development.⁴⁷ Most of these countries have about one-third as much road infrastructure as Afghanistan but the countries themselves are all substantially larger. For reference, the United States has .477km of paved road per km².⁴⁸ Afghanistan has .065 km of road for every km² of territory. Of that .065 km/km², only .019 km is paved, the other .046 km is unpaved road. By comparison, the ratio of paved road to overall land area in Mauritania, Mali or Niger is .003 km/km²; only one-sixth as much paved road per km² as Afghanistan. Total road, both paved and unpaved were less than one-fifth of Afghanistan's ratio, with Mauritania having .011km/km² and Mali and Niger both having .015km/km². In light of these numbers, if road transportation has proven problematic for logistics during OEF then the situation will only be worse in Western Africa.

Algeria and Nigeria are both substantially better developed nations than Afghanistan; with hydrocarbon based economies and corresponding revenues to spend on infrastructure. Algeria's GDP is eight times Afghanistan's while Nigeria's GDP is over 13 times larger.⁴⁹ So it should come as no surprise those countries have more roadways than Afghanistan. Nigeria in particular, as the smallest of the five African countries being surveyed, actually has .2 km of road for every km² of territory. This is about 3 times greater than Afghanistan's road ratio of .065 km/km².

Algeria boasts 87,000 km of paved road out of 113,000 km of roads, making it the only country being discussed with more paved roads than unpaved roads.⁵⁰ However, two factors mitigate what would look like a positive story at initial glance. The sheer size of Algeria means

that the actual ratio of road to territory is still less than in Afghanistan. Overall road ratio in Algeria is .048km/km², about three-fourths Afghanistan's ratio. While it is true that Algeria boasts double Afghanistan's paved road rate, it is important to realize that the vast majority of those paved roads are clustered along the Mediterranean, rarely extending more than 150 miles from the coast. Additionally, while Algeria is not land locked that does not mean that fuel can reach the southern area of the country any easier than it could reach Afghanistan by land. For example, the distance traveled from Karachi, Pakistan to any of the Afghan border crossings is only roughly one-third of the distance between Algeria's coast and its southern border with Mali or Niger. Covering the last two-thirds of the trip is equivalent to driving north to south across Afghanistan twice. Obviously, it is no small task to get fuel to the southern portion of Algeria to support operations against AQIM.

All this data points a bleak picture for logistical support of air operations in Western Africa. Roads are less common place than in Afghanistan, so the prevalence of ambushes or IEDs to frustrate resupply efforts are likely to be repeated with similar or greater levels of success during military operations in Western Africa. Efforts to bring in fuel by land may actually be even more complicated because the distances that have to be crossed are even greater than the US has dealt with over the past decade, and without the use of light attack, only a fraction of the roads are under the cover of air support. In order to provide air support for supply convoys using legacy fighters at very limited bases, tankers would have to supply fuel to the fighters to extend their range and on station time. In the end an operation like this may be a 'self-licking ice cream cone' where the legacy fighters require tanker support so they can have enough range to fly cover for all of the ground convoys needed to bring them fuel. But exactly how much gas would be involved?

An F-16 with 2 drop tanks, which is part of a normal combat load, can hold 12,000 lbs of fuel. Based on the Air Forces assertion that the F-16 has a 500 nm combat range traveling at a cruise speed of 480 KTAS it is reasonable to assume an unrefueled flight time of about 2.5 hours.⁵¹ Taking into consideration some sort of fuel reserve, say 10 percent of onboard fuel, it is also reasonable to conclude that F-16s burn around 4,000 lbs of fuel per flight hour. The F-15E carries three times as much fuel as the F-16. However, that fuel is feeding two engines that are pushing an aircraft that weights twice as much as the F-16. Based on the basic laws of physics it is reasonable to assume that the F-15E burns about 8,000 lbs per hour and can probably manage a flight time of around 4 hours without air refueling. For simplicity's sake the fuel requirements for the F-16 will be investigated here, with the understanding that any fuel requirements for the F-16 would be doubled if F-15E aircraft were deployed. Looking at several light attack aircraft, fuel requirements are substantially lower. The Super Tucano, fully loaded uses around 330 lbs of fuel per hour. Meanwhile the AT-6B uses around 340 lbs per hour.⁵²

A 5,000 gallon fuel truck holds 33,500 lbs of JP-8 (6.7 lbs/gallon). A single fuel truck can supply almost 100 flight hours for a light attack aircraft. Two light attack aircraft could be airborne 24 hours a day and only require a single fuel truck every 2 days. Compare that to F-16 operations, where 33,500 lbs of fuel only keeps a two-ship airborne between breakfast and lunch. Over a two day period of operations, light attack aircraft would need one fuel truck, while F-16 operations would need 12 fuel trucks to keep two aircraft airborne 24 hours a day.

What about the cost of tanker support? Is it really so bad to rely on tankers to extend the range and flight time for legacy fighters? Envision the USAF supporting operations in Mali in much the same way France has. F-16 fighters will be based a Bamako while tanker assets are in Abidjan, Cote d' Ivoire. As discussed earlier the main operations are now taking place around

Goa. How much does it cost to provide 4 hours of air support to ground operations around Goa using two USAF legacy aircraft? Cruising at 480 KTAS the F-16s from Bamako can arrive over Goa in about 1.25 hours. They can then provide 4 hours of air support before flying 1.25 hours back to Bamako. This is a total of 6.5 flight hours per F-16, so 13 flight hours for the whole mission. In order to remain airborne this long tanker support from Abidjan will be required. A KC-135 could launch from Abidjan and cover the 800 miles to Goa in about 1 hour 40 minutes, assuming about the same cruise speed as the F-16s, 480 KTAS. If the KC-135 refueled the F-16s once, when they arrived over Goa, and then one more time after 2 hours over Goa the tanker could then proceed back to Abidjan. This would be 5 hours and 20 minutes of flight time for the KC-135.

According to the Department of Defense comptroller, F-16 hourly usage rates for 2013 are about \$9,400 per hour. KC-135 rates are \$10,400 per hour.⁵³ In this scenario, 4 hours of air support cost \$177,663. How much would the same support have cost with a light attack aircraft? First of all the light attack aircraft could have been based out of Goa so there is no travel time. So 4 hours of air coverage in support of operations around Goa will require 8 flight hours by a 2-ship formation of light attack aircraft. Although the USAF does not operate AT-6B aircraft, the 2013 rate for T-6A aircraft is \$559 per hour.⁵⁴ Previous research has estimated light attack versions of the T-6A would cost just under \$1,600 per hour to operate.⁵⁵ It seems pessimistic to assume that operating costs for a light attack version of a trainer would be triple the trainer version's costs, but for the sake of argument a conservative approach is prudent. Eight hours of flight time at \$1600 per hour would cost \$12,800, or just over seven percent of the cost to accomplish the same mission with legacy fighters. Now imagine what the rate would have been if the light attack aircraft had simply sat ground alert. Being so close to the operations makes

this a reasonable option light attack aircraft could employ. While legacy fighters based 600 miles away must launch and fly to the area of operations to provide the similar response capability.

The current USAF force structure is not well suited to the realities of future conflicts. Domestic political policy as well as budget constraints are going limit US commitment of assets and resources to conduct low intensity operations. The threat from transnational terrorism is not simply going away, however. AQIM and other Islamist organizations in Western Africa are a great example of the kinds of threats the USAF may be tasked to counter in the near future. The current USAF legacy fighters are not the best response to these threats in light of reduced budgets. The airfield infrastructure in Mauritania, Mali, Niger, Nigeria and Algeria is too spartan to support low cost operations for high performance fighters. The limited number of airfields long enough to safely operate fast jets for an extended duration means that to cover the vast areas of Western Africa tanker support will have to be used, or air coverage will be isolated in very small areas of these countries. Additionally, the amount of fuel required to keep legacy fighters airborne would tax the rudimentary road infrastructure of this area.

Light attack fighters on the other hand would have significantly greater basing options. The vast majority of areas where AQIM and other Islamic movements operate could be covered from smaller airfields by light attack aircraft, without the need for airborne tankers. The modest logistical requirements to keep light attack aircraft operating would not overburden the road structure. Finally, the costs associated with light attack operations are significantly smaller than legacy fighter operations. The cost per hour for operations for a light attack platform is roughly 15 percent of an F-16. This does not even factor in the cost for operating tankers, which are

required to get the same air coverage from legacy fighters that light attack can provide because of more abundant basing options.

There is no question that the infrastructure problems investigated in this survey are not particular to Western Africa. A very similar situation exists in Southeast Asia and the Pacific, where the US interests are shifting in our “Pivot to the Pacific”. With domestic politics demanding low footprint, low cost support for future low intensity conflicts the USAF would be prudent to invest in a light attack platform to keep operations viable in less developed parts of the world.



Endnotes

¹ Russell J. Smith, "Common Sense at the Crossroads for Our Air Force," *Air & Space Power Journal* (March-April 2012): 92, <http://www.airpower.au.af.mil/digital/pdf/articles/Mar-Apr-2012/Smith.pdf>.

² Ibid., 93-95.

³ Lt Col Michael W. Pietrucha, "Seeing the Whole Elephant," *Air & Space Power Journal* (Fall 2010): 43, http://www.airpower.au.af.mil/airchronicles/apj/apj10/fal10/2010_3_04_pietrucha.pdf.

⁴ Mackenzie Eaglen and Doug Birkey, "Air Force Cuts Mean Service Is 'Slowly Going Out of Business'," *AOL Defense* (August 8, 2012), <http://defense.aol.com/2012/08/08/air-force-is-slowly-going-out-of-business-service-stands-on/>.

⁵ Johnathan Masters, "Backgrounder: Al-Qaeda in the Islamic Maghreb," Council on Foreign Relations (October 15, 2012), <http://www.cfr.org/north-africa/al-qaeda-islamic-maghreb-aqim/p12717#p4>.

⁶ Will Hartly, ed., *IHS Jane's World Insurgency and Terrorism 2012*, (n.p.: Odyssey Press, 2012), 42, 112.

⁷ Ibid., 118.

⁸ The White House, *The National Security Strategy of the United States of America*, (Washington, DC: US Government Printing Office, May 2010), 21.

⁹ Masters, "Al-Qaeda in the Islamic Maghreb"

¹⁰ Ibid.

¹¹ David Hartwell, ed., *IHS Jane's Sentinel: Country Risk Assessment, West Africa 2012*, (n.p. Odyssey Press, 2012), 449.

¹² Masters, "Al-Qaeda in the Islamic Maghreb"

¹³ Richard Wood, *Call sign Rustic: The Secret Air War Over Cambodia, 1970-1973*, (Washington, DC: Smithsonian Institution Press, 2002).

¹⁴ SrA Brok McCarthy, "7 years that were 66 years in the making," 379th Air Expeditionary Wing Public Affairs (April 14, 2009), <http://www.379aew.afcent.af.mil/news/story.asp?id=123144243>.

¹⁵ SSgt Markus Maier, "Upgraded A-10s prove worth in Iraq," U.S. Central Command Air Forces Combat Correspondent Team (7 November, 2007), <http://www.af.mil/news/story.asp?id=123074946>.

¹⁶ "Al Asad Airbase, Al Anbar, Iraq," Airforce-technology.com, accessed December 10, 2012, <http://www.airforce-technology.com/projects/al-asad-airbase-iraq/>.

¹⁷ SrA Amber R. Kelly-Herard, "The final days of Joint Base Balad," 332nd Air Expeditionary Wing Public Affairs (November 26, 2011), <http://www.afcent.af.mil/news/story.asp?id=123281264>.

¹⁸ Jim Loney, "Huge U.S. air base returned to Iraqi control," Reuters (November 9, 2011), <http://www.reuters.com/article/2011/11/09/us-iraq-usa-balad-idUSTRE7A82KG20111109>.

¹⁹ Bruce Rolfsen, "Afghan Base Runways Challenge U.S. Pilots," *Defense News* (August 22, 2005): 35, [http://infoweb.newsbank.com/iw-search/we/InfoWeb?p_action=doc&p_topdoc=1&p_docnum=1&p_sort=YMD_date:D&p_product=NewsBank&p_text_direct=0=document_id=\(%2010C680C8F82E3F78%20\)&p_docid=10C680C8F82E3F78&p_theme=aggdocs&p_queryn](http://infoweb.newsbank.com/iw-search/we/InfoWeb?p_action=doc&p_topdoc=1&p_docnum=1&p_sort=YMD_date:D&p_product=NewsBank&p_text_direct=0=document_id=(%2010C680C8F82E3F78%20)&p_docid=10C680C8F82E3F78&p_theme=aggdocs&p_queryn)

ame=10C680C8F82E3F78&f_openurl=yes&p_nbid=A53K55IIMTM1NTE3OTM4OS42MzY5MzA6MToxNDoxMzIuMTc0LjI1NS43Nw&&p_multi=DFNB.

²⁰ Lt Col Michael W. Pietrucha, "Logistical Fratricide" *Armed Forces Journal* (January/February 2012), 15.

²¹ Capt Vince King, Jr., "Wing begins new chapter with F-15E," 455th Air Expeditionary Wing Public Affairs (January 17, 2007), <http://www.bagram.afcent.af.mil/news/story.asp?id=123037786>.

²² TSgt Joseph Kapinos, "Bagram Airfield opens \$68 million runway," 455th Air Expeditionary Wing Public Affairs (December 21, 2006), http://www.bagram.afcent.af.mil/news/story_print.asp?id=123035900.

²³ "Bagram, Airport information," Jeppesen Chart Viewer, Jeppesen Sanderson, Inc., <https://www.jeppesen.com/icharts/index.jsp>.

²⁴ Ministry of Defense (Netherlands), "Dutch F-16 fighters complete 10 years in Afghanistan," (November 2, 2012), http://www.defensie.nl/english/latest/news/2012/11/02/48200490/Dutch_F_16_fighters_complete_10_years_in_Afghanistan.

²⁵ Ministry of Defense (Netherlands), "Royal Netherlands Air Force F-16 missions from Kandahar come to an end," (October 15, 2012), http://www.defensie.nl/english/latest/news/2011/10/19/48188664/Royal_Netherlands_Air_Force_F_16_missions_from_Kandahar_come_to_an_end.

²⁶ Rolfsen, "Afghan Base Runways Challenge."

²⁷ "New Kandahar runway completed," *Air Force Times* (November 6, 2006), <http://www.airforcetimes.com/legacy/new/1-292925-2332226.php>.

²⁸ Pietrucha, "Seeing the Whole Elephant," 43.

²⁹ "Pocket Gunship: From AC-XX to the MC-27J," *Defense Industry Daily* (July 12, 2012), <http://www.defenseindustrydaily.com/AC-XX-Gunship-Lite-A-C-27J-Baby-Spooky-05001/#replacement-planes>.

³⁰ "MC-27J: SpecOps Stinger Platform at a Sale Price," *Defense Industry Daily* (July 12, 2012), <http://www.defenseindustrydaily.com/AC-XX-Gunship-Lite-A-C-27J-Baby-Spooky-05001/#replacement-planes>.

³¹ "C-27 J Essential Facts," L-3 Communications, accessed December 11, 2012, <http://www.c27j.com/essential-facts>.

³² Pietrucha, "Seeing the Whole Elephant," 49.

³³ Ministre de la Défense, "Serval: situation update, between Monday, 4 March, and Thursday, 7 March, 6 pm," (March 12, 2013), <http://www.defense.gouv.fr/english/content/view/full/196077>.

³⁴ Ministre de la Défense, "Une historisée," (April 9, 2013), <http://www.defense.gouv.fr/english/portail-defense/une-historisee>.

³⁵ Ministre de la Défense, "Operation Serval: update on the 14 February 2013," (February 18, 2013), <http://www.defense.gouv.fr/english/content/view/full/193272>.

³⁶ Ministre de la Défense, "Situation update on Operation Serval in Mali, Thursday, 7 February 6:00 pm - Monday, 11 February 6:00 pm," (February 12, 2013), <http://www.defense.gouv.fr/english/content/view/full/192682>.

³⁷ Ministre de la Défense, "Operation Serval: update on 21 February 2013," (February 26, 2013), <http://www.defense.gouv.fr/english/content/view/full/194429>.

³⁸ Lindsay Peacock and Alexander von Rosenbach, ed., *IHS Janes World Air Forces 2013*, (no publisher), 488.

- ³⁹ Central Intelligence Agency, "Nigeria: Transportation," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html>.
- ⁴⁰ Sabine Machenheimer and Alexander von Rosenbach, ed., *IHS Jane's Sentinel: Country Risk Assessment, Central Africa 2012*, (n.p. Yurchak Printing, Inc., 2012), 489.
- ⁴¹ Central Intelligence Agency, "Afghanistan: Transportation," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/geos/af.html>.
- ⁴² Sabine Machenheimer and Alexander von Rosenbach, ed., *IHS Jane's Sentinel: Country Risk Assessment, Central Africa 2012*, (n.p. Yurchak Printing, Inc., 2012), 526.
- ⁴³ Lindsay Peacock and Alexander von Rosenbach, ed., *IHS Janes World Air Forces 2013*, (no publisher), 10-11.
- ⁴⁴ Paul Cruickshank and Tim Lister, "Algeria attack may have link to Libya camps," CNN (January 23, 2013), <http://www.cnn.com/2013/01/18/world/africa/algeria-attackers/index.html>.
- ⁴⁵ Pietrucha, "Logistical Fratricide," 15.
- ⁴⁶ Tom Wright, Adam Entous and Julian Barnes, "Pakistan Says U.S. Gave Wrong Information on Hit," Wall Street Journal (December 3, 2011), <http://online.wsj.com/article/SB10001424052970204012004577074042444708750.html>.
- ⁴⁷ Central Intelligence Agency, "Afghanistan, Mali, Mauritania and Niger: Economy," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/index.html>.
- ⁴⁸ Central Intelligence Agency, "Afghanistan, Mali, Mauritania and Niger: Transportation," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/index.html>.
- ⁴⁹ Central Intelligence Agency, "Algeria and Nigeria: Economy," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/index.html>.
- ⁵⁰ Central Intelligence Agency, "Algeria and Nigeria: Transportation," *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013), <https://www.cia.gov/library/publications/the-world-factbook/index.html>.
- ⁵¹ United States Air Force, "F-16 Fighting Falcon Factsheet," (May 21, 2012), <http://www.af.mil/information/factsheets/factsheet.asp?id=103>.
- ⁵² Pietrucha, "Logistical Fratricide," 16
- ⁵³ Office of the Under Secretary of Defense (Comptroller), "Fiscal Year (FY) 2013 Department of Defense (DoD) Fixed Wing and Helicopter Reimbursement Rates," (October 12, 2012), http://comptroller.defense.gov/rates/fy2013/2013_f_h.pdf.
- ⁵⁴ Ibid.
- ⁵⁵ Maj David L. Peeler, "Counterinsurgency Aircraft Procurement Options," (Maxwell Air Force Base, AL: Air University Press, August 2009), 23.

Bibliography

- "Al Asad Airbase, Al Anbar, Iraq," Airforce-technology.com. Accessed December 10, 2012.
<http://www.airforce-technology.com/projects/al-asad-airbase-iraq/>.
- "C-27 J Essential Facts." L-3 Communications. Accessed December 11, 2012.
<http://www.c27j.com/essential-facts>.
- Central Intelligence Agency. *The World Factbook 2013* (Washington, DC: Central Intelligence Agency, 2013). <https://www.cia.gov/library/publications/the-world-factbook/index.html>.
- Cruikshank, Paul and Tim Lister. "Algeria attack may have link to Libya camps." CNN (January 23, 2013). <http://www.cnn.com/2013/01/18/world/africa/algeria-attackers/index.html>.
- Eaglen, Mackenzie and Doug Birkey. "Air Force Cuts Mean Service Is 'Slowly Going Out of Business'." *AOL Defense* (August 8, 2012). <http://defense.aol.com/2012/08/08/air-force-is-slowly-going-out-of-business-service-stands-on/>.
- Hartly, Will, ed. *IHS Jane's World Insurgency and Terrorism 2012*. n.p.: Odyssey Press, 2012.
- Hartwell, David, ed. *IHS Jane's Sentinel: Country Risk Assessment, West Africa 2012*. n.p. Odyssey Press, 2012.
- Jeppesen Chart Viewer. Jeppesen Sanderson, Inc. <https://ww1.jeppesen.com/elink/services/index.jsp>.
- Kelly-Herard, SrA Amber R. "The final days of Joint Base Balad." 332nd Air Expeditionary Wing Public Affairs (November 26, 2011). <http://www.afcent.af.mil/news/story.asp?id=123281264>.
- King, Capt Vince, Jr. "Wing begins new chapter with F-15E." 455th Air Expeditionary Wing Public Affairs (January 17, 2007). <http://www.bagram.afcent.af.mil/news/story.asp?id=123037786>.
- Loney, Jim. "Huge U.S. air base returned to Iraqi control." Reuters (November 9, 2011). <http://www.reuters.com/article/2011/11/09/us-iraq-usa-balad-idUSTRE7A82KG20111109>.
- Machenheimer, Sabine and Alexander von Rosenbach, ed. *IHS Jane's Sentinel: Country Risk Assessment, Central Africa 2012*. (n.p. Yurchak Printing, Inc., 2012).
- Maier, SSgt Markus. "Upgraded A-10s prove worth in Iraq." U.S. Central Command Air Forces Combat Correspondent Team (7 November, 2007). <http://www.af.mil/news/story.asp?id=123074946>.

Masters, Johnathan. "Backgrounder: Al-Qaeda in the Islamic Maghreb." Council on Foreign Relations (October 15, 2012). <http://www.cfr.org/north-africa/al-qaeda-islamic-maghreb-aqim/p12717#p4>.

"MC-27J: SpecOps Stinger Platform at a Sale Price." *Defense Industry Daily* (July 12, 2012). <http://www.defenseindustrydaily.com/AC-XX-Gunship-Lite-A-C-27J-Baby-Spooky-05001/#replacement-planes>.

McCarthy, SrA Brok. "7 years that were 66 years in the making." 379th Air Expeditionary Wing Public Affairs (April 14, 2009). <http://www.379aew.afcent.af.mil/news/story.asp?id=123144243>.

Ministre de la Défense. "Une historisée." Accessed April 9, 2013. <http://www.defense.gouv.fr/english/portail-defense/une-historisee>.

Ministry of Defense (Netherlands). "Royal Netherlands Air Force F-16 missions from Kandahar come to an end." (October 15, 2012). http://www.defensie.nl/english/latest/news/2011/10/19/48188664/Royal_Netherlands_Air_Force_F_16_missions_from_Kandahar_come_to_an_end.

Ministry of Defense (Netherlands). "Dutch F-16 fighters complete 10 years in Afghanistan." (November 2, 2012). http://www.defensie.nl/english/latest/news/2012/11/02/48200490/Dutch_F_16_fighters_complete_10_years_in_Afghanistan.

"New Kandahar runway completed." *Air Force Times* (November 6, 2006). <http://www.airforcetimes.com/legacy/new/1-292925-2332226.php>.

Pietrucha, Lt Col Michael W. "Seeing the Whole Elephant." *Air & Space Power Journal* (Fall 2010): 42-58. http://www.airpower.au.af.mil/airchronicles/apj/apj10/fal10/2010_3_04_pietrucha.pdf.

Office of the Under Secretary of Defense (Comptroller). "Fiscal Year (FY) 2013 Department of Defense (DoD) Fixed Wing and Helicopter Reimbursement Rates." (October 12, 2012). http://comptroller.defense.gov/rates/fy2013/2013_f_h.pdf.

Peacock, Lindsay and Alexander von Rosenbach, ed. *IHS Janes World Air Forces 2013*. (n.p.).

Peeler, Maj David L. "Counterinsurgency Aircraft Procurement Options." (Maxwell Air Force Base, AL: Air University Press, August 2009).

Pietrucha, Lt Col Michael W. "Logistical Fratricide" *Armed Forces Journal* (January/February 2012).

"Pocket Gunship: From AC-XX to the MC-27J." *Defense Industry Daily* (July 12, 2012).

<http://www.defenseindustrydaily.com/AC-XX-Gunship-Lite-A-C-27J-Baby-Spooky-05001/#replacement-planes>.

Rolfesen, Bruce. "Afghan Base Runways Challenge U.S. Pilots." *Defense News* (August 22, 2005). [http://infoweb.newsbank.com/iw-search/we/InfoWeb?p_action=doc&p_topdoc=1&p_docnum=1&p_sort=YMD_date:D&p_product=NewsBank&p_text_direct-0=document_id=\(%2010C680C8F82E3F78%20\)&p_docid=10C680C8F82E3F78&p_theme=aggdocs&p_queryname=10C680C8F82E3F78&f_openurl=yes&p_nbid=A53K55IIMTM1NTE3OTM4OS42MzY5MzA6MToxNDoxMzIuMTc0LjI1NS43Nw&&p_multi=DFNB](http://infoweb.newsbank.com/iw-search/we/InfoWeb?p_action=doc&p_topdoc=1&p_docnum=1&p_sort=YMD_date:D&p_product=NewsBank&p_text_direct-0=document_id=(%2010C680C8F82E3F78%20)&p_docid=10C680C8F82E3F78&p_theme=aggdocs&p_queryname=10C680C8F82E3F78&f_openurl=yes&p_nbid=A53K55IIMTM1NTE3OTM4OS42MzY5MzA6MToxNDoxMzIuMTc0LjI1NS43Nw&&p_multi=DFNB).

Smith, Russell J. "Common Sense at the Crossroads for Our Air Force." *Air & Space Power Journal* (March-April 2012): 90-117. <http://www.airpower.au.af.mil/digital/pdf/articles/Mar-Apr-2012/Smith.pdf>.

United States Air Force. "F-16 Fighting Falcon Factsheet." (May 21, 2012). <http://www.af.mil/information/factsheets/factsheet.asp?id=103>.

The White House. *The National Security Strategy of the United States of America*. (Washington, DC: US Government Printing Office, May 2010).

Wood, Richard. *Call sign Rustic: The Secret Air War Over Cambodia, 1970-1973*. (Washington, DC: Smithsonian Institution Press, 2002).

Wright, Tom, Adam Entous and Julian Barnes. "Pakistan Says U.S. Gave Wrong Information on Hit." *Wall Street Journal* (December 3, 2011). <http://online.wsj.com/article/SB10001424052970204012004577074042444708750.html>.

Appendix A

Country	Name	City	Length	Source	Notes
Mauritania	Kaedi	Kaedi	8200	Jep	
Mauritania	Nouakchott	Nouakchott	9800	Jep	
Mauritania	Atar	Atar	9800	Jep	
Mauritania	Nouadhibou	Nouadhibou	7900	Jep	
Mauritania		Bir Moghrein	1800m	Janes	
Mauritania		Aioun el-Atrouss	1600m	Janes	
Mauritania		Kiffa	1600m	Janes	
Mauritania		Nema	2100m	Janes	
Mauritania		Selibabi	1200m	Janes	
Mauritania		Tichit	2700m	Janes	Unpaved
Mauritania		Zouerat	2400m	Janes	Unpaved
Mauritania		Tidjikaja	1600m	Janes	Unpaved
Mali	Senou	Bamako	10400	Jep	
Mali	Goundam	Goundam	4900	Jep	
Mali	Korogoussou	Gao	8200	Jep	
Mali	Dag Dag	Kayes	8800	Jep	
Mali	Ambededjo	Mopti	8200	Jep	
Mali	Nioro	Nioro	4900	Jep	
Mali	Dignangan	Sikasso	5200	Jep	
Mali	Tombouctou	Tombouctou	6800	Jep	
Mali	Tessalit	Tessalit	8200	Jep	
Niger	Diori Hamani	Niamey	9800	Jep	
Niger	Manu Dayak	Agades	9800	Jep	
Niger	Zinder	Zinder	5900	Jep	
Niger		Tahoua	2100m	Janes	
Niger		Diffa	1800m	Janes	
Niger		Maradi	1700m	Janes	
Niger		Dirkou	1600m	Janes	
Nigeria	Nnamdi Azikwe Intl	Abuja	11800	Jep	
Nigeria	Akwa Ibom Intl	Uyo	11800	Jep	
Nigeria	Benin	Benin	7800	Jep	
Nigeria	Margaret Ekpo	Calabar	8000	Jep	
Nigeria	Akanu Ibiam	Enugu	7800	Jep	
Nigeria	Gombe	Gombe	10800	Jep	
Nigeria	Ilorin	Ilorin	10100	Jep	
Nigeria	Sam Mbakwe	Owerri	8800	Jep	
Nigeria	Yakubu Gowon	Jos	9800	Jep	
Nigeria	New Kaduna	Kaduna	9800	Jep	

Nigeria	Mallam Aminu Kano	Kano	10800	Jep	
Nigeria	Katsina	Katsina	11400	Jep	
Nigeria	Maiduguri	Maiduguri	9800	Jep	
Nigeria	Murtala Muhammed	Lagos	12700	Jep	
Nigeria	Minna	Minna	11100	Jep	
Nigeria	Port Harcourt	Port Harcourt	9800	Jep	
Nigeria	Saddiq Abubakar Intl	Sokoto	9800	Jep	
Nigeria	Yola	Yola	9800	Jep	
Algeria	Bou Saada	Bou Saada	7200	Jep	
Algeria	Soummam-Abane Ramdane	Bejaia	7800	Jep	
Algeria	Houari Boumediene	Algiers	11400	Jep	
Algeria	Tiska	Djanet	9800	Jep	
Algeria	Takhamalt	Illizi	9800	Jep	
Algeria	8 Mai 45	Setif	7800	Jep	
Algeria	Aguenar-Hadj Bey Akhamok	Tamanrasset	11800	Jep	
Algeria	Ferhat Abbas	Juel	7800	Jep	
Algeria	Rabah Bitat	Annaba	9800	Jep	
Algeria	Mohamed Boudiaf	Constantine	9800	Jep	
Algeria	Cheikh Larbi Tebessi	Tebessa	9800	Jep	
Algeria	Mostepha Ben Boulaid	Batna	9800	Jep	
Algeria	Abdelhafid Boussouf Bou Chekif	Tiaret	9800	Jep	
Algeria	Tindouf	Tindouf	9800	Jep	
Algeria	Chlef	Chlef	9100	Jep	
Algeria	Zenata-Messali El Hadj	Tlemcen	8500	Jep	
Algeria	Ahmed Benbella	Oran	11800	Jep	
Algeria	Boudghene Ben Ali Lotfi	Bechar	10900	Jep	
Algeria	Ghriss	Ghriss	5500	Jep	
Algeria	El Bayadh	El Bayadh	9800	Jep	
Algeria	In Guezzam	In Guezzam	7200	Jep	
Algeria	Bordj Mokhtar	Bordj Mokhtar	9800	Jep	
Algeria	Touat Cheikh Sidi Mohamed Belk	Adrar	9800	Jep	
Algeria	Mohamed Khider	Biskra	9500	Jep	
Algeria	El Golea	El Golea	9800	Jep	
Algeria	Noumerat-Moufdi Zakaria	Ghardaia	10100	Jep	
Algeria	Oued Irara-Krim Balkacem	Hassi Messaoud	9800	Jep	
Algeria	In Salah	In Salah	9800	Jep	
Algeria	Sidi Mahdi	Touggourt	9800	Jep	
Algeria	Guemar	El Oued	9800	Jep	
Algeria	Timimoun	Timimoun	9800	Jep	
Algeria	Ain Beida	Ouargla	9800	Jep	

Algeria	In Amenas	Zarzaitine	9800	Jep	
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