Global Power Requires a Global, Persistent Air-to-Air Capability

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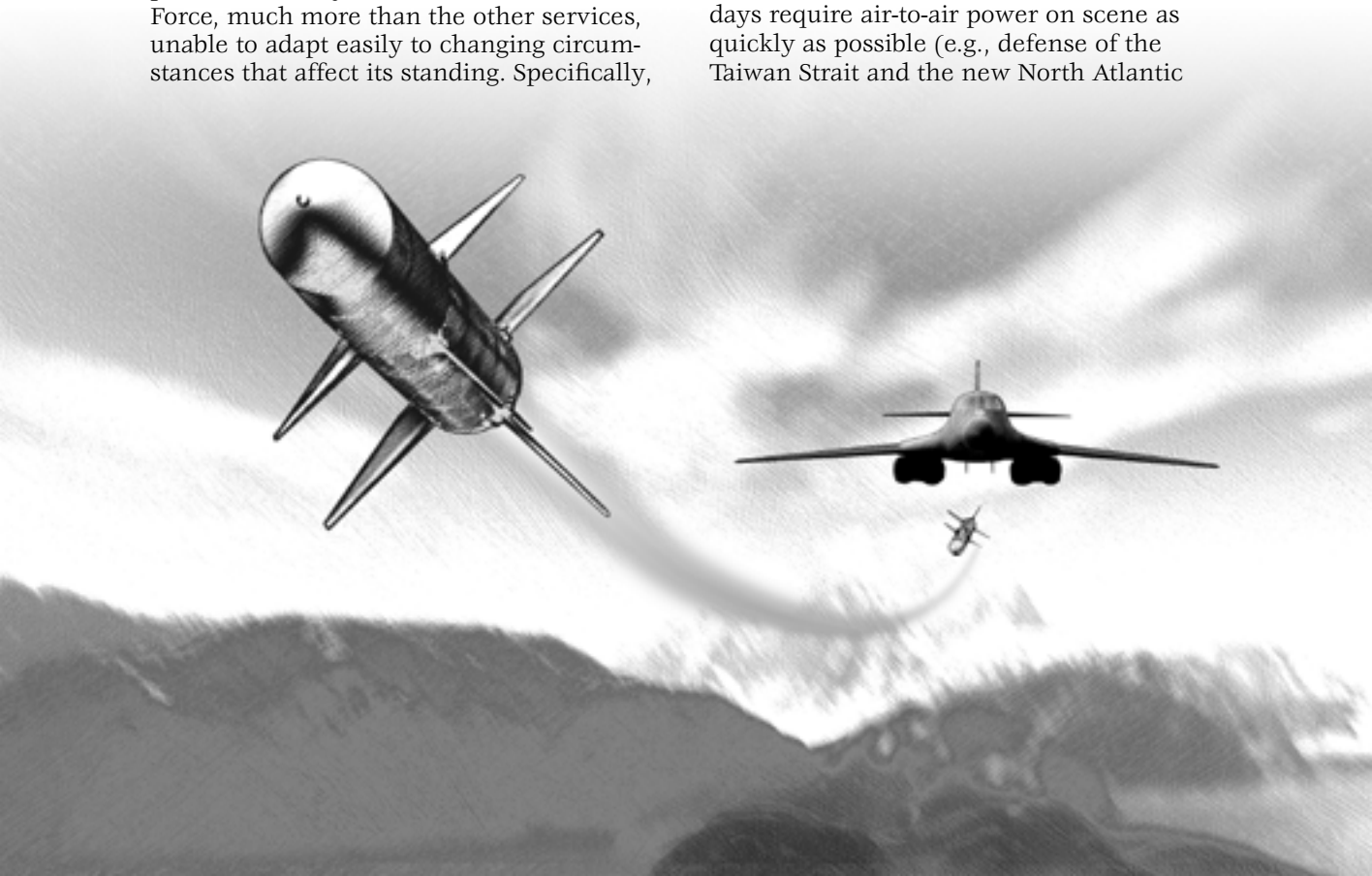
During the last decade, the US Air Force saw its status begin to wane significantly with respect to the other US armed forces, in part due to a change in the focus of American foreign policy, high costs of the wars in Iraq and Afghanistan, and the rise of powers such as China and India. However, fixation on certain narrow areas of military power and airpower over the years has made the Air Force, much more than the other services, unable to adapt easily to changing circumstances that affect its standing. Specifically, our service has failed to maintain its ability to conduct general military operations by having lost sight of the essence of airpower—gaining and maintaining air superiority. More to the point, it has never emphasized the projection of air-to-air airpower at intercontinental ranges, let alone with any persistence at those distances.

Although this deficiency has negatively affected the status of the Air Force, more importantly, it has left the United States lacking in a key area. Almost all of the major conventional military scenarios with which the United States is concerned these days require air-to-air power on scene as quickly as possible (e.g., defense of the Taiwan Strait and the new North Atlantic



Treaty Organization member states along the Baltic, where we have only limited immediate capability). Currently we measure our deployment time of forces to most regions in weeks. If the Air Force had a true long-range air-to-air capability, the United States could exert its influence within hours. Potentially, the Air Force could approximate the capabilities of an Aegis ship or aircraft carrier in any region of the world within 24 hours and sustain operations for a week.[1] However, we do not seem to recognize the absence of such an option—a potential game changer—as a deficiency. But the need is obvious in many places worldwide.

Traditionally, when we think of air-to-air capability, we think of fighter aircraft. This article explores the specific "effect" of being able to shoot down an opposing aircraft at an intercontinental distance from a home airfield.[2] Although current fighter aircraft might produce this effect, the article examines alternative air-breathing remotely piloted and piloted airborne means of doing so.[3] Evidently the fastest way to attain minimum capability in this area with our current technology involves modifying a bomber, such as a B-1. In the longer term, other methods might be better, but only with a substantial expenditure of funds.[4]

The Geopolitical Need

We can probably gain air superiority more efficiently by attacking enemy aircraft at their bases or by targeting ground-based resources critical to their employment, but an abundance of historical material yields examples of times when such attacks proved impossible. Often, political reasons mandated that an air force gain and maintain air superiority without attacking the enemy's bases or vital logistical resources—as in the Korean War, for instance.[5] Additionally, various no-fly zones imposed during the 1990s had varying restrictions on what the Air Force could do against ground targets associated with opposing air forces. We have every reason to expect similar political impediments in the future. We can put an air-to-air capability into position only by moving ground-based aircraft to a base or positioning an aircraft carrier within range of the area of interest. Unfortunately, moving aircraft to forward bases is a ponderous process, measured at least in days. Positioning a carrier may actually prove faster, assuming the possibility of moving one close enough.

Flying a long-range air-to-air-capable aircraft into an area of interest to establish a no-fly zone while follow-on forces deploy could deter many potential conflicts and offer decisive advantages in other scenarios. In particular, this effect could be the ultimate solution to "antiaccess" strategies of opposing military powers.

The Problem

In the 1950s, the Air Force considered itself the premier branch of the US military because of its status as the only service that had a viable intercontinental nuclear strike capability. During this era, Strategic Air Command (SAC) eliminated long-range fighter escorts since it deemed such aircraft unnecessary for intercontinental nuclear strikes.[6] In the 1960s, with the advent of the submarine-launched ballistic missile and the Vietnam War, the Air Force's status declined accordingly. The Navy could claim that its nuclear delivery bested the Air Force's, and the Army declared that future wars would be conventional, not nuclear.

With the reemergence of conventional war as the focus, the bomber generals in the Air Force gave way to the fighter generals in the 1970s and 1980s.[7] Unfortunately, both groups fixated on their specialized areas at the expense of true long-range capability in conventional combat. The bomber generals emphasized nukes rather than conventional capability and overall flexibility, and the fighter generals concentrated on short-range, intratheater conventional war, based on support to the Army in Europe and Korea. This trend left the Air

Force with only two air missions still unique to that service—long-range bombing and long-range airlift. The current leadership of the Air Force still includes many fighter generals who may think they have long-range fighters as well—but they don't.

We in the Air Force view reality in the context of what we are used to, and we don't notice when our reality becomes anachronistic. Obviously, B-2, B-52, and B-1 bombers can strike targets at intercontinental ranges, and C-17s and C-5s can deliver cargo at those distances. Obviously as well (and by some standards anachronistic if anyone ever thought about it), Air Force fighters cannot conduct counterair operations at anywhere near the same intercontinental ranges at which bombers and transports operate—a clear contrast to the Navy's capability. Navy transport ships range the globe with military equipment, much like Air Force transport aircraft. Additionally, however, Navy warships can intercept any ship—civilian or military, unarmed or armed—anywhere on the high seas, and in most coastal waters as well, and sink them if necessary by using guns, missiles, or torpedoes. Current Air Force air superiority aircraft can only intercept and, if necessary, shoot down other aircraft within a relatively short distance from their ground bases, even with in-flight refueling. A rapid program to give the Air Force a long-range air-to-air capability would correct this deficiency, address current criticism from Congress and pundits, and help silence the chorus of voices questioning the Air Force's existence as a separate service.[8]

The Theoretical Context

Almost all airpower theorists agree upon the necessity of establishing air superiority, the most fundamental principle of airpower, when conducting air campaigns or most other forms of war in the modern age.[9] Historical examples from World War II and subsequent conflicts seem to support this theory. Most theorists also agree that the easiest, most effective way to gain air superiority does not involve the destruction of individual enemy aircraft in air-to-air combat; rather, it calls for attacking them on the ground at their airfields or neutralizing them by eliminating something critical to their employment, such as fuel supplies or factories that produce them.[10] Even so, experience shows that despite strikes against enemy aircraft at their airfields or against related production facilities, air forces usually have to destroy opposing aircraft in air-to-air combat.[11] In fact, one cannot say with certainty that any air force has ever achieved air superiority solely by bombing ground targets.[12]

Given the historical record, the American military's serious deficiency in projecting air-to-air combat at any significant range from US borders or bases is surprising. This weakness, which seriously hampers America's ability to react to various crises, has largely escaped theoretical discussions of airpower strategy over the years. Most discussions address the types of ground targets to hit rather than how to establish air superiority at global ranges.[13] The Air Force should correct this problem because a true long-range air-to-air capability would significantly enhance the military options available to our national leadership and because we could realize at least a rudimentary capability at relatively low cost.

The Historical Record

One of the classic stories in the history of the Air Force, that of the P-51 Mustang in World War II, deals specifically with long-range air-to-air capability, yet today's Air Force strangely ignores the lessons of that experience. Every aviation history enthusiast knows that the United States began the war believing in high-altitude daylight bombing as the proper way to project airpower. When we put this prewar assumption into practice in the skies over Germany, however, we soon began to question its validity.[14] Losses sustained by the bomb-

ers were so great that the Army Air Forces quickly curtailed bombing raids at ranges that prevented fighter escort.[15] Introduction of the P-51 Mustang as the critical long-range escort fighter enabled US forces to resume bombing raids deep into German airspace and quickly sweep European skies of German aircraft.[16] Less well understood is that the P-51's victory over the Luftwaffe proceeded not simply from escorting bombers but from using it offensively to seek out and destroy enemy fighters in flight, at their airfields, and anywhere else.[17]

After the war, the newly created SAC took over the long-range bomber mission.[18] Much like the mixed bomber and fighter force that defeated the Luftwaffe, SAC retained a long-range air-to-air capability consisting of its own escort fighter aircraft until the late 1950s.[19] From the beginning, though, the short range of these fighters presented a problem. As the bombers reached intercontinental ranges, it became increasingly difficult to manufacture a fighter with the range to escort them. The development of air-to-air refueling seemed to solve this problem—and to some degree it did. However, by then SAC had lost interest in fighters, and tactical aircraft made the only gains in fighter range.

Regrettably, air-to-air refueling only appeared to solve the range problem for fighter aircraft. No equivalent increases in range have occurred since then. Crew fatigue has become the primary limiting factor. Simply put, a single-seat fighter is a very uncomfortable place after only six or seven hours of continuous flying. Given a fighter's maximum cruising rate as something just short of the speed of sound, the combat radius of a typical single-seat fighter aircraft, even with air-to-air refueling, falls far short of intercontinental range.[20]

Fundamental Restrictions on Range

Basic physics limits solutions to both the fuel and crew fatigue problems for fighter aircraft. In a sense, we are approaching the limits of what we can do with chemical fuels. To obtain the energy necessary to propel them to intercontinental distances, aircraft must carry substantial weight in the form of fuel. In fact, more than half the total weight of a fully loaded long-range bomber aircraft is its fuel.[21]

From World War I to the present, fighters have depended heavily on maneuverability, acceleration, and speed to allow them to get into a position to shoot down opposing aircraft.[22] Adding fuel capacity is the most obvious way to increase their range.[23] Similarly, the most transparent way of solving the problem of crew fatigue involves adding an additional crew member or increasing space on the aircraft so that the pilot can rest either en route or on station—or both. Adding space and fuel capacity essentially equates to increasing the aircraft's weight, which adversely affects maneuverability, acceleration, and even speed. Hence the dilemma: adding weight to gain range compromises air-to-air performance.

More than anything else, this has irreconcilably constrained attempts to increase the unrefueled range of a fighter aircraft. Indeed, the unrefueled range of a vintage P-51 Mustang is not substantially different than that of the modern F-22.[24]

Theoretical Views and Divergence from Theory

Giulio Douhet's classic work *The Command of the Air*, originally published in 1921, promoted the "battle plane" as the best type of aircraft with which an air force could attain "command of the air."[25] In his view, such an aircraft was heavily armored and armed, having a greater range than bombers but not remarkable speed, compared to that of pursuit planes used in World War I. However, in World War II, though heavily armed, bombers could not consistently shoot down enough attacking fighters to defend themselves. Additionally, given the practical limitations on aircraft

armor (i.e., unwanted weight), aircraft have become light, delicate machines unable to withstand much damage from air-to-air or ground-to-air weapons.

Furthermore, in World War II most aircraft used either machine guns or rapid-fire cannons as air-to-air weapons. During the Vietnam War, though, air-to-air guided missiles made their debut, both in radar-guided and infrared heat-seeking versions, and the Air Force fielded some fighters without any gun armament at all.[26] However, missile-armed fighters of the Vietnam era had to maneuver to the enemy aircraft's six o'clock position before firing on it, much like gun-armed aircraft of the past.[27] Fighters not equipped with a gun proved deficient, so later models included that weapon.[28] Since then, practically all air-to-air missiles can engage targets from directions other than the six o'clock position and now do most of the maneuvering.

In retrospect, one might argue that the abortive move to all-missile armament was simply ahead of its time, at least in the air-to-air arena. In the last 30 years of American, Israeli (equipped with US aircraft), and British (Falklands War) engagements between fighter aircraft, missiles scored all of the air-to-air kills—the internal gun, none.[29] Reliance on fighter aircraft maneuverability over the last 40 years or so, however, caused fighter range to stagnate. Acknowledging that the fighter aircraft itself is only about 90 years old, perhaps after 40 years we should revisit the issue and consider forfeiting maneuverability in favor of operational range.

Alternatives for Establishing an Intercontinental Air-to-Air Capability

Over the years, we have seen many proposals for new long-range systems, most of which emphasized long-range "global strike" systems either to replace or augment our current long-range bombers. Few have worried much about air-to-air capability—and that attitude needs to change. Realistically, any global strike concept should include such a capability, and several paths could take us in that direction.

One alternative involves extending the range of a small, lightweight, highly maneuverable fighter-type aircraft. The other dispenses with maneuverability, utilizes a large airframe capable of carrying its own fuel for long-range operations, and mounts air-to-air systems on that airframe. Clearly, a brand new aircraft design would best serve either of these choices; however, current budget constraints relegate this ideal to something little more than fantasy. To a greater or lesser degree, both the bomber advocates' follow-on bomber and the fighter advocates' F-22 have already succumbed to budget realities. A new platform supported by neither camp has no chance. In reality, if the Air Force is to realize any intercontinental air-to-air capability in the near term, it will have to consist of relatively inexpensive modifications to existing systems. Thus, the most viable option seems to call for equipping at least a small number of B-1B bombers with a relatively long-range, off-the-shelf air-to-air missile system.

Extending the Effective Range of Maneuverable Fighter-Type Airframes

As mentioned before, theoretically, aerial refueling gives our existing fighter aircraft unlimited range, realistically limited only by pilot fatigue. (But rearmament of a fighter that carries only six to 10 air-to-air missiles and the matter of equipment reliability and maintenance also could present problems.) Thus, extending the range of existing aircraft primarily involves replacing the pilot of the short-range platform with a fresh pilot. Moreover, we must consider tanker aircraft, whose vulnerability increases the closer they come to a threat.

Obviously, replacing the pilot allows the short-range fighter to maintain its maneuverability. Since the aircraft would still depend on tankers to provide fuel for intercontinental flight, the added weight of fuel is no longer a consideration. Replacing the pilot involves either a literal exchange, which would require some sort of airborne aircraft carrier, or complete removal, as in a remotely piloted aircraft (RPA).

Airborne Aircraft Carrier

Over the years, proposals to build airborne aircraft carriers have resulted in the Navy airships of the 1930s and the F-84 and F-85 parasite fighter programs, which attained various levels of operational capability.[30] These carrier initiatives envisioned large, long-range aircraft that transported fighter-sized aircraft to a launch position and then recovered them after they flew operational sorties.

A slightly different concept involves a "mother ship" that would rearm the fighter and switch pilots but would not normally carry the smaller aircraft to and away from the target area. Such a mother ship could service numerous fighters, which would depend on air refueling and their own engines to fly most of the distance to the target area. Essentially, this entails the next step from air-to-air refueling: air-to-air repiloting and rearming.

Unfortunately, neither the airborne aircraft carrier nor the mother ship exists. Modifying existing aircraft or designing and building new ones would incur considerable expense.

Remotely Piloted Aircraft

In the long term, removing the pilot from the airframe may offer the best solution. However, the RPA fighter has yet to reach operational status. We have built several prototypes, but apparently a number of so-far-undisclosed challenges remain, perhaps including the air refueling of an RPA and maintaining the data link with it in order to control the aircraft during an air-to-air engagement in an electronic combat environment.

Air refueling requires difficult maneuvering in close proximity to aerial tanker aircraft and raises various safety concerns. Until air refueling becomes a proven capability for RPAs, they will remain relatively short-range systems.[31]

With regard to the data link, a remote pilot flies the Predator—our primary operational, fighter-sized RPA—via this means.[32] However, any enemy able to electronically jam the data link of an RPA fighter could render it an easy target in an engagement. Moreover, the control inputs are not instantaneous; that is, a latency (time lag) occurs between the remote pilot's input and the RPA's response.[33] Using a remote operator (standard operating procedure for the Predator) data-linked by geostationary satellite inherently involves substantial latency. Only by locating the remote operator closer to the RPA, preferably with a line-of-sight data link, could we overcome this problem.

A reusable, maneuverable, or nonmaneuverable RPA with substantial loiter time might eventually prove a useful addition to long-range air-to-air capability, but it remains some years away. It would probably require a long-range mother ship in nearby orbit, with the RPA pilot on board, to reduce jamming vulnerability and overcome the latency issue.

Giving Long-Range Systems Air-to-Air Capability

Although we can arm aircraft already capable of long-range flight, we have no real way of making them as maneuverable as smaller aircraft. If we can surmount the limitations of a nonmaneuverable "fighter," however, certain advantages accrue to a system that has its own long-range capability. We can either use an off-the-shelf long-range system or design and build such a system from the ground up as an "intercontinental fighter."

Modifying an Off-the-Shelf System

Possible off-the-shelf systems include long-range transports and bombers. Because many commercial and military long-range transports are in production, we could easily obtain them from different manufacturers. Similarly, off-the-shelf bombers already have some of the offensive and defensive systems that we might want in a "fighter"—and bombers may have a speed advantage as well.

Modified Airliner or Transport. Historically, proposals to produce a "missile truck" usually called for modifying an airliner such as the Boeing 747 to carry and fire many air-to-air missiles, in many cases leaving all the targeting to other aircraft. Needless to say, unless the other aircraft also has long range, this "buddy system" does not result in intercontinental capability. An Airborne Warning and Control System (AWACS) aircraft, modified to have a targeting capability, might serve as a "buddy" platform. Furthermore, the E-3 AWACS, a modified airliner, would lend itself to the other option, namely having an airliner-type aircraft with a self-contained, intercontinental air-to-air capability. Installing a fire-control radar and an air-to-air missile-launch capability on an E-3 AWACS or another airliner airframe would result in a self-contained, intercontinental air-to-air capability. The cost of modifying such aircraft for significant missile-launch capability and fire-control radar remains unclear, however.

Modified Bomber. Perhaps the most intriguing option concerns equipping an existing bomber with air-to-air capability. Since all three bombers in the US inventory have similar ranges and payloads, any of them, like the transport, could serve as a missile truck for carrying and launching air-to-air missiles, and, with the appropriate modification, any of them could target the missiles as well. The B-1 might be the best candidate for such a conversion. Indeed, fitting a B-1 with the radar currently used in the F-15E could give the bomber some capabilities similar to those of the F-15E but with vastly increased range and payload.[34]

Building a True Long-Range Fighter

Although designing and building an aircraft specifically as a long-range fighter or air superiority aircraft represent the ideal option, it is probably the most expensive one and would require substantial time to reach operational status. In concert with a true long-range air-to-air combat aircraft, we might develop RPAs to complement the overall system.[35] Either tankers or the long-range manned combat aircraft itself could refuel the RPAs to give them comparable range, and then a pilot on the combat aircraft could control them via a line-of-sight data link. This combination of RPA and long-range combat aircraft might provide the ideal synergy needed to take on almost any foreseeable adversary at intercontinental range. But the expense of developing such a capability, though perhaps no more than that of an aircraft carrier task force, would be extreme.

The Best Option

Given the realities of the situation, modifying the B-1 bomber for an air-to-air capability offers the best option. In the current political and budgetary environment, we probably could develop a true long-range air-to-air capability only by doing so quickly, at minimal cost, to get an operational aircraft on line before political support erodes, a requirement that favors the B-1. A program to develop a rudimentary operational capability within a year would require (1) installing in the B-1's nose radome an air-to-air fire-control radar capable of targeting, such as an off-the-shelf F-15E radar, (2) fitting it with an appropriate radar-guided missile, such as the AIM 120 advanced medium-range air-to-air missile (AMRAAM) (even though it lacks the desired range), and (3) setting up appropriate equipment in the crew compartment for operating the system and electronically inter-

facing the parts of the system.[36] If we use the B-1's weapon bays, equipped with rotary launchers currently used for air-to-ground weapons, one proposal from Boeing would enable each plane to carry 48 AMRAAMs, 16 in each weapons bay.[37] Eventually, the maximum ranges of AMRAAM-like missiles would vary from bay to bay.

The AMRAAM, however, has a relatively short range.[38] Eventually, the B-1 would require an AMRAAM or some other air-to-air missile with longer range that would take advantage of the bomber's ability to carry a larger missile and would reduce its vulnerability to a similarly equipped enemy fighter aircraft. A logical evolutionary progression would eventually culminate in a long-range B-1 multirole aircraft that could approximate all of the capabilities of the Navy's Aegis vessels but enjoy substantially better high-speed reaction and less vulnerability to enemy aircraft, submarines, and missiles. Mating such a long-range manned aircraft with an air-refuelable, AMRAAM-armed RPA could provide an even better solution to the problem of attaining intercontinental air superiority.

Conclusion

In many ways, the US Air Force and even manned heavier-than-air flight itself are still in their infancy, the former having existed for less than a century and the latter now moving into its second century. Clearly, despite repeated predictions of their impending demise, air-breathing platforms have certain militarily significant capabilities—such as range, speed, and persistence—that remain difficult to replicate by means of any currently available technology. If the Air Force wishes to stay viable, it must maximize its exploitation of these attributes and avoid unnecessary capabilities that hamper its ability to do so. Given the air-breathing aircraft's inherent long-range, high-speed capability, which the bomber and transport communities have long exploited, it seems that long range is an area we can further develop in the air superiority arena.

Manned, highly maneuverable fighter aircraft have been a fixture in air forces since the early days of World War I. Perhaps our continued fixation on the maneuverability (hence, short range) of these platforms will someday seem as antiquated as the importance of being able to fire machine guns through the propeller arc of planes during World War I. In any case, if the Air Force intends to maintain credibility, it must rise above the expeditionary, close air support air forces of the other services and bring to bear an air-to-air capability across intercontinental distances without depending on nearby but vulnerable foreign bases. ✪

Notes

1. An extensively modified B-1 could accommodate most of the capabilities of Aegis cruisers and destroyers (e.g., antiair, long-range strike, ballistic missile defense, antisubmarine, and antiship). The bomber could reach the operating area faster than a ship but would not have the ship's persistence. "Cruisers—CG," United States Navy Fact File, 28 October 2009, accessed 24 May 2010, http://www.navy.mil/navydata/fact_display.asp?cid = 4200&tid = 800&ct = 4.

2. We also need an airborne platform that can shoot down theater ballistic missiles at intercontinental ranges, but that topic lies beyond the scope of this article.

3. Space might provide this capability as well but probably not for several decades. With the exception of geosynchronous orbits, space offers only limited "persistence."

4. Whereas retired Air Force colonel Phillip Meilinger explores range and persistence in the context

of global strike, I address the air-to-air aspect of global strike, particularly in terms of attaining minimal capability in minimal time. Col Phillip S. Meilinger, "Range and Persistence: The Keys to Global Strike," *Air and Space Power Journal* 22, no. 1 (Spring 2008): 66, accessed 1 July 2010, http://www.airpower.au.af.mil/airchronicles/apj/apj08/spr08/spr08.pdf.

5. Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (New York: Free Press, 1989), 19.

6. Marcelle Size Knaack, *Post–World War II Fighters, 1945–1973* (Washington, DC: Office of Air Force History, 1985), 140.

7. Maj James M. Ford, "Air Force Culture and Conventional Strategic Airpower" (thesis, School of Advanced Airpower Studies, 1993), accessed 1 July 2010, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA425510&Location=U2&doc=GetTRDoc.pdf.

8. Robert Farley, "Abolish the Air Force," *American Prospect* 18, no. 10 (1 November 2007), accessed 21 June 2010, http://www.prospect.org/cs/articles?article=abolish_the_air_force.

9. Dr. David R. Mets, "To Kill a Stalking Bird: Fodder for Your Professional Reading on Air and Space Superiority," *Airpower Journal* 12, no. 3 (Fall 1998): 74, accessed 1 July 2010, http://www.airpower.au.af.mil/airchronicles/apj/apj98/fal98/mets.pdf.

10. Giulio Douhet, *The Command of the Air* (1927; repr., Norwalk, CT: Easton Press, 1994), 18–19.

11. LTC Andrew B. Twomey, "What's Left of Douhet?," essay (Washington, DC: National War College, 1999), 5, accessed 1 July 2010, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA442704&Location=U2&doc=GetTRDoc.pdf.

12. Carriers and air bases located in the Middle East provided fighter escorts for the initial air strikes during Operation Enduring Freedom in Afghanistan. Additionally, one can argue that the United States established air superiority over Japan in World War II without an air-to-air fighter-like capability. Even so, US forces captured Iwo Jima specifically for that purpose since they could not do so from the B-29 bomber bases in the Mariana Islands.

13. Twomey, "What's Left of Douhet?," 7–9.

14. Richard G. Davis, *Bombing the European Axis Powers: A Historical Digest of the Combined Bomber Offensive, 1939–1945* (Maxwell AFB, AL: Air University Press, April 2006), 112, accessed 1 July 2010, http://www.au.af.mil/au/aul/aupress/books/Davis_B99/Davis_B99.pdf.

15. Ibid., 184.

16. Ibid., 184–201, 275–94.

17. Ibid., 290–94.

18. Walton S. Moody, *Building a Strategic Air Force* (Washington, DC: Air Force History and Museums Program, 1996), 63–66.

19. Walter J. Boyne, *Beyond the Wild Blue, A History of the United States Air Force, 1947–1997* (New York: St. Martin's Press, 1997), 107.

20. Ibid.

21. For example, a fully loaded B-52 can weigh approximately 488,000 pounds at takeoff. Ordnance might account for as little as 25,500 pounds (approximately the weight of a full load of 51 Mark 82 500-pound bombs). Fuel represents approximately 275,000 pounds, and the empty weight of the aircraft—about 187,500 pounds—makes up the rest. Hence the fuel weighs more than 10 times as much as the bombs, and about one and a half times as much as the empty aircraft. "B-52 Stratofortress," fact sheet, US Air Force, 23 April 2010, accessed 19 August 2010, http://www.af.mil/information/factsheets/factsheet.asp?id=83.

22. Mets, "To Kill a Stalking Bird," 75.

23. Davis, *Bombing the European Axis Powers*, 187.

24. Although an incredibly large number of factors affects aircraft range, various sources say that the range of a P-51 is approximately 2,000 miles, similar to that of the F-22. Some of these factors include altitude, the presence of drop tanks and/or external stores, and the weight of internal stores.

25. Douhet, *Command of the Air*, 117–42.

26. Mets, "To Kill a Stalking Bird," 86.

27. Ibid., 94; "AIM-9 *Sidewinder* Missile," United States Navy Fact File, 20 February 2009, accessed 1 July 2010, http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=1000&ct=2; and "AIM-9 Sidewinder," fact sheet, US Air Force, 27 January 2010, accessed 17 April 2010, http://www.af.mil/information/factsheets/factsheet.asp?id=78.

28. Knaack, *Post–World War II Fighters*, 277.

29. Mets, "To Kill a Stalking Bird," 73.

30. Col George D. Kramlinger, "Narrowing the Global-Strike Gap with an Airborne Aircraft Carrier," *Air and Space Power Journal* 19, no. 2 (Summer 2005): 85, accessed 1 July 2010, http://www.airpower.au.af.mil/airchronicles/apj/apj05/sum05/sum05.pdf.

31. Global Hawk currently has an intercontinental range of sorts. Certainly, the aircraft would have much more range if it were air refuelable. Global Hawk, as well as any other RPA, is a relatively short-range system compared with an air-refuelable version. Arguably, even a B-1-sized RPA wouldn't have the range of a B-1 unless it was air-refuelable.

32. "MQ-1B Predator," fact sheet, US Air Force, 29 June 2010, accessed 17 April 2010, http://www.af.mil/information/factsheets/factsheet.asp?id=122.

33. Col Bruce Emig, Headquarters Air Combat Command / A8Q, to the author, e-mail, February 2010.

34. It might even be possible either to simply use the existing B-1 radar or modify it. I have assumed a worst-case scenario of having to use a completely different radar. Use of the existing radar would make the change that much easier.

35. Emig, e-mail.

36. The first two developmental Joint Surveillance Target Attack Radar System aircraft deployed in 1991, during the first Gulf War, before they were officially operational, supporting Operation Desert Storm by detecting and locating enemy armor so that strike aircraft could attack. "E-8C Joint Stars," fact sheet, US Air Force, 28 September 2007, accessed 24 May 2010, http://www.af.mil/information/factsheets/factsheet.asp?id = 100.

37. Lt Col Alejandro Gomez, USAF, Air Combat Command / A8I, to the author, e-mail, July 2009.

38. Combined with limitations on the B-1, the missile's short range would mean that an AMRAAM launched by that bomber would usually have less range than one launched by a fighter aircraft. Hence, opposing fighter aircraft with missiles having ranges equal to or greater than the AMRAAM's would put the B-1 at a disadvantage, even with its long-range radar shot. Optimization of the B-1 for low-altitude flight is responsible for this issue. The AMRAAM and other air-to-air missiles can take advantage of the high speed and relatively high altitude of the launching fighter aircraft. The B-1B is a very fast low-altitude aircraft, but its low-observable design features limit its speed and altitude. The higher it flies, the slower it goes. Hence, any missile launched from it gets less of a range boost than it would from a faster fighter aircraft.

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