Sea-Land Basing of Air Refueling Forces

A Concept for Resiliency and Efficiency

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This discussion proposes a serious look at an old concept in a new application—providing sea-based support of US Air Force air refueling forces at forward land bases in the face of modern antiaccess/area-denial (A2/AD) threats. Given the proliferation of robust A2/AD capabilities in the hands of potential enemies, this concept offers theater commanders the possibility of operating air refueling forces efficiently and with resilience.[1] It would do so by freeing some of those forces from dependence on large, fixed, and heavily defended air bases. Put another way, sea basing could transform tanker aircraft and support elements from predictable targets waiting for the next shot to peas in a fast-moving shell game—one presenting difficult-to-impossible detection and targeting challenges for enemy command systems.

To set it apart from the many other versions of sea basing discussed in the literature of national defense, the article refers to this notion as sea-land basing (SLB). Essentially, SLB is a concept for the *agile disaggregation* of air refueling forces among austere military and civil airfields possessing minimal support facilities for large aircraft other than runways. The signature characteristic of SLB would be the dedicated integration of at least one "missionized" base ship with an expeditionary air refueling unit of up to about 20 aircraft. This ship would house the command, logistics, maintenance, personnel, and other elements needed to support dispersed expeditionary air refueling operations at several airfields simultaneously. At a given time, one or two of those airfields would serve as forward operating locations (FOL) able to service and protect aircraft and crews assigned to the SLB unit and/or those transiting through from bases or aircraft carriers located further to the rear. In addition to the FOLs, an SLB ship would service a small number of "hide" airfields, providing protection and limited services only. The main difference between FOLs and hides is that the former would offer robust, expeditionary aircraft refueling support while the latter would not. Otherwise, both types of base would be manned and resourced on a minimal and highly mobile basis, capable of being disembarked and set up or packed up and reembarked in just a few hours.

As a preliminary and largely qualitative examination of SLB, this study argues two salient points. First, it asserts that SLB offers enough potential advantages in operational capacity and resilience to justify robust study and experimentation on behalf of one or more geographic combatant commands. Second, this article maintains that the present Air Force air refueling program-of-record fleet—what it has and what it plans to acquire—is not structured to exploit the full potential of SLB. Getting the most from SLB in the face of robust A2/AD capabilities likely will require adjustments in the planned air refueling force structure. These discussions begin with a little history.

History

The long history of sea basing speaks to the practicality and potential value of SLB. As early as World War I and for decades thereafter, the US Navy employed seaplane tenders to support reconnaissance and bombing operations at remote locations. During World War II, the Navy, Marine Corps, and Army Air Forces made extensive use of ships in support of land-based air operations. The Army Air Forces' Project Ivory Soap, for example, consisted of 6 Liberty and 18 smaller ships to serve as floating warehouses and heavy maintenance depots for B-29 and P-51 groups in the Pacific.[2] In the 1960s, the Navy employed the USS *Tallahatchie County* (AVB-2) as an advanced aviation support base in the Mediterranean.[3] Presently, the Ready Reserve Fleet includes two ships, the USS *Wright* (T-AVB-3) and USS *Curtis* (T-AVB-4), that serve as advanced logistics and maintenance support bases for Marine aircraft.[4] Their exercises include the use of T-AVBs in support of ashore aircraft ranging from attack helicopters to C-130s.[5]

The USS *Tallahatchie County* experience provides a particularly relevant analog to SLB since it involved the prolonged integration of an amphibious base ship and rotating squadrons of P-2 Neptune patrol aircraft. The Navy redesignated the *Tallahatchie*, originally built as a 6,000-ton landing ship tank (LST 1154), as an advance aviation base support ship in early 1962. In that role, the ship was modified to house the supplies, maintenance shops (engines, avionics, sheet metal, etc.), and crew complements (the ship's, air crew, and aviation support) needed to keep up to nine Neptunes in operation for months. The support divisions sent ashore were housed in 19 service trailers stored on the ship's vehicle deck while under way. These included command, communications, meteorology, crew briefing, flight-line maintenance, medical, galley, and others. Upon arriving at a forward location, the AVB would beach, lower its ramp, and disgorge two-and-one-half-ton trucks towing the service trailers to the forward base, carrying tentage and supplies for a cantonment area. With experience, the ship's personnel could begin ashore operations at a coastal airfield less than four hours after the ship beached, breaking down and reembarking the unit in as little time.[6] Once deployed, the P-2 squadron commanders were integrated into the ship's company, serving as chiefs of the *Tallahatchie*'s aviation division but taking their operational orders from the theater-level commander of the Anti-Submarine Warfare Force Sixth Fleet.[7]

The Antiaccess/Area-Denial Threat to Air Refueling Forces

Although the United States is no more likely to go to war with China than with other potential enemies that wield substantial A2/AD capabilities, Chinese military forces offer a useful standard for assessing basing options. For over two decades, China has been "pursuing a variety of air, sea, undersea, space and counterspace, and information warfare systems and operational concepts . . . moving toward an array of overlapping, multilayered offensive capabilities extending from China's coast into the western Pacific."[8] Further, Chinese strategists have identified mobility forces, including tankers, as key and vulnerable targets in the event of a conflict with the United States.[9]

China's A2/AD order of battle is robust, multilayered, and increasingly capable. It begins with an array of land-based, airborne, and satellite-based intelligence, surveillance, and reconnaissance (ISR) systems capable of searching the globe episodically and the western Pacific more or less continuously.[10]

To exploit these capabilities, China fields 1,900 combat aircraft (600 of which are modern); over 1,000 short-range ballistic missiles (SRBM);

a "limited but growing" fleet of DF-21C and D medium-range ballistic missiles (MRBM); and hundreds of DF-1, -2, and -3 cruise missiles.[11] All of these weapon systems can deliver precision-guided ordnance. The DF-21 and cruise missile elements are particularly important to any considerations of air refueling force basing since they can reach all established US air bases in Korea, Japan, and the so-called first and second island chains in the western Pacific. Further, unclassified documents estimate that these systems have average impact accuracies (circular error probable) of 10–50 meters.[12] In other words, if fired at known or predictable locations of tanker aircraft and not stopped or deflected by US defenses, these missiles likely will hit their targets.

Given the growing sophistication and weight of Chinese A2/AD capabilities, most analysts presume that basing large aircraft within their range would court disaster.[13] The large size of tanker aircraft and their extensive support requirements make them vulnerable to long-range strikes, even by "shots in the blind" at predictable aircraft parking locations. Constructing costly shelters for air refueling aircraft could improve their survivability at forward bases, but, as more than one strategist has pointed out, "no matter how good a HAS [hardened aircraft shelter] might be, a penetrating projectile can be built to defeat it."[14] Consequently, many studies would agree that US tankers and other large aircraft "should be operated from bases out of range of China's conventional ballistic missiles."[15]

However, there is reason to think that China's long-range strike capabilities will not be a "coordinated whole" anytime soon. The Chinese military is neither well versed nor structured to practice the art and science of coordinating joint ISR and strike forces in high-tempo operations. China is searching for a "Chinese model" for joint command and control, of course, but its quest is hampered or at least constrained by a host of national economic, social, and political circumstances beyond its control.[16] Important among these are the potential political consequences of transforming the Chinese officer corps into a culture of nationalism, professional skill, and integrity in the service of a ruling political elite characterized by self-serving, faux communist orthodoxy; nepotism; and corruption.[17] Until those competency problems are solved, therefore, the Chinese military will remain capable of launching effective operations in the preplanned opening gambits of a conflict but potentially uncertain and slow in dealing with unfolding events in the face of the fog and friction of war and competent enemies fighting back.[18]

Furthermore, the weight and persistence of Chinese attacks will decrease over distance and in the face of counterstrikes. Because of China's limited air-to-air refueling capabilities and lack of experience with establishing expeditionary air bases, its ability to project all-capabilities "gorilla strikes" against US bases will be restricted to about 400 nautical miles (nm) from its mainland—the approximate operational radii of weapons-laden fighter aircraft.[19] Fighters and China's small fleet of H-6 bombers will supply the weight of "gorilla ring" strikes, augmented by missiles and perhaps special operations forces (SOF). Missile augmentation will drop drastically beyond about 350 nm since that is the range limit of China's SRBMs, which comprise the majority of its missile magazine.[20] Further, beyond 400 miles, the scale of the Chinese aircraft attacks would be limited to the H-6 fleet and whatever fighter packages could be supported by its small air refueling force. Consequently, outside the gorilla ring, missiles will become the main threat to US air bases. Missiles are dangerous, but a few hundred MRBMs and cruise missiles will not match the power and persistence of attack possible inside the gorilla threat ring. Moreover, the outer boundary of the "missile ring" would be limited to the approximately 1,000 nm range of the DF-21 MRBMs and HN-3 land-based cruise missiles. Chinese naval ships and submarines could launch cruise missile strikes against bases deeper into the Pacific; however, the weight of their attacks would be relatively limited, and they would be exposed to US and allied detection and counterattacks.

Advantages

These considerations of Chinese command and strike capabilities suggest an opportunity to operate tanker forces from within the missile ring—one offering enhanced resilience and operational effectiveness for air refueling forces. The agile disaggregation of SLB bases and forces would enhance their resilience by denying Chinese commanders the confidence they would want before releasing precious weapons against fleeting targets. Their lack of confidence would reflect reality since the locations of at least some FOLs and hide bases in SLB would shift daily while the aircraft and other key assets on each operating airfield would change position more or less hourly. Further, with the bulk of SLB assets embarked, these base movements would impose minimal disruption on operational efficiency. Additionally, their locations in the missile ring would improve their ability to deliver fuel to supported combat aircraft.

The unpredictable and agile disaggregation of SLB air refueling forces will be the key to their resilience. They will be unpredictable because opening those bases would not depend on the existence of preconflict physical or contractual preparations, or expensive and politically sensitive base-access agreements. In other words, preparations for SLB would not signal intent to use any specific bases.[21] Camouflage discipline, emissions security, and other deception operations could delay the detection of active FOLs, hides, and even the base ship's locations for hours—even days. Enemies who did discover the locations of operating bases would remain uncertain about where to aim their long-range weapons and residual gorilla strike packages. By the time the decision to release precious assets filters through a sluggish and deteriorating political and military command system, the aircraft and support teams on those fields at the time of detection may well have moved on. Even if an airfield were still in operation, tugs would move the few aircraft on it every few hours between dispersal sites. This dynamic dispersal tactic would invalidate enemy targeting information more than a few hours old and ensure that no two aircraft were ever close enough to be destroyed by a single area weapon or unitary warhead. In most situations, then, enemies sniping at sea-land refueling bases would be shooting in the blind, hoping against reasonable hope that their weapons would do more than just move dirt when they arrived.

Operating air refueling aircraft from inside the missile ring rather than from beyond it will enhance their operational efficiency in two ways. First, at least in the western Pacific, doing so will increase the number of bases and parking spots available for air refueling aircraft. A glance at a map of the western Pacific reveals many civil and military airfields located within the range of DF-21 missiles launched from China and relatively few among the scattered islands further out in the Pacific. With more bases available, SLB units could operate closer to the fight, and they would be less likely to find themselves competing with combat units for scarce parking spaces.[22] Second, moving into the missile ring would greatly increase the amount of fuel that tanker aircraft will be able to off-load to receiver aircraft.

The operational geography of maintaining an air refueling orbit 250 nm west of Manila during a crisis in the South China Sea serves as an instructive example of the efficiencies gained from moving tankers into the missile rings. Basing tankers at Tacloban Airport, in the southeastern Philippines, would put them in the middle of the missile ring but only about 510 miles from the orbit point. Operating those same tankers from Pelieliu or Tinian islands would put them beyond the range of Chinese DF-21s but also about 1,125 or 1,700 nm from the refueling point, respectively. Table 1 indicates the effect of increased distance on the net off-load capacity on KC-46s and C-130Js.[23]

Table 1. Off-load at refueling point (x 1,000 pounds)
(presumes round-trip transit, two hours on station, and one hour reserve fuel)

Aircraft/Departure Base	*Tacloban*	*Pelieliu*	*Tinian*
KC-46	165	138	113
KC-130	50	32	14

Predictably, the tyranny of distance would be greater for the smaller and slower KC-130J, which would lose 75 percent of its productivity from a shift to Tinian from Tacloban, while the bigger and faster KC-46 would lose about 33 percent. For perspective, consider that F-35s will burn about 9,000 pounds of fuel per hour in cruise flight. Thus, a C-130 making the 10-hour round trip from Tinian could off-load enough fuel to extend a single fighter's endurance about 1.5 hours and burn 50,000 pounds of fuel itself making the trip.

Bases

Sea and land bases will be essential to the agility and resilience of SLB. Consequently, though SLB remains too undeveloped conceptually to support a detailed discussion of its base elements—the ship, FOLs, and hides—it remains useful here to list some of the tasks and equipage likely required of them.

The SLB ship would be "missionized" to fulfill the tasks necessary to support ashore units, including

- transporting all of an air refueling unit's personnel, equipment, and supplies over strategic distances at respectable maritime speeds of, say, at least 20 knots;
- debarking, sustaining, and embarking the personnel, equipment, and supplies needed at FOLs and hides at minimally developed ports or over the shore in matters of hours;
- transporting and assembling ship-to-air base fuel systems, such as the Air Force's Expeditionary Fuel System or a variation of the Marine Corps's Amphibious Assault Fuel Systems and Tactical Airfield Fuel Dispensing System, and connecting them to supporting tanker ships;[24]
- conducting close-in self-defense against likely threats, including aircraft, cruise missiles, torpedoes, fast boats, and SOF; and

- providing reinforcements and close air support to ashore security teams under threat from enemy SOF or other small raiding units.

To conduct these missions, the equipage of SLB ships likely should include

- amphibious craft for ship-to-shore moving of FOL, hide, and base-opening/-closing teams and for conducting logistics operations when the ship is near a base or bases;
- optionally armed, multimission utility helicopters to provide ship-to-shore logistics, mobility, and close air support to ashore units;
- at least two ship-to-shore bulk fuel systems, each with enough capacity to support 12–20 air refueling aircraft in high-tempo operations; and
- a sensor and weapons suite capable of providing adequate surveillance and close-in defense against likely threats.

Compared to the two aviation support ships currently in the Maritime Prepositioning Fleet, a ship built or modified for SLB need not be particularly large or expensive. The USS *Curtis* and *Wright* displace around 50,000 tons, but they have a wide portfolio of missions and exercise frequently in support of the full range of Marine Corps aviation support, humanitarian-relief operations, and exercises.[25] An SLB ship, in contrast, would be dedicated to the support of a single, moderately sized aviation unit. In that case, a ship the size of a 16,000–18,000-ton amphibious transport dock (LPD) might suit the mission. In its original configuration, one of the retiring *Austin*-class LPDs, for example, can accommodate over 1,200 personnel, up to 6 helicopters, different types of landing craft, food for 2 months, a 12-bed medical clinic, and large numbers of vehicles and maintenance shop spaces. Of relevance, the USS *Ponce* (LPD-15) was converted for $60 million into an interim afloat forward staging base (AFSB [I]-1) in 2012 to sustain special operations and countermine activities in the Arabian Gulf.[26] Of course, other ships could be converted to the SLB mission. The point is that the physical requirements for an SLB ship are modest and need not break the bank to acquire.

Given their center-of-gravity importance to the overall SLB concept, it is useful to pause here to consider the survivability of SLB base ships. In reasonable likelihood, an SLB ship would prove as survivable as the other amphibious warfare and surface combatant vessels that the US and allied navies would have to operate in the missile ring. Constant maneuver would be the keystone of a base ship's resilience. It would move constantly, pausing periodically only for an hour or two to disembark or reembark FOL and hide teams or to exploit a hide position of its own. Other evasion tactics available to the ship would include combinations of camouflage, terrain and shallow-water masking, and emissions masking and deception. Its smaller size and freighter-like horizontal and overhead profiles would make it more difficult for long-range radar and overhead infrared and electroptical sensors to parse it out from general maritime traffic. The ship also should be equipped with the close-in electronic and kinetic defensive systems typical of other amphibious warfare ships. When employed as the terminal layer of the overall offensive and defensive operations of a US and/or allied force, such systems would give the base ship a fighting chance to defeat or divert incoming bombs, missiles, torpedoes, small-boat attacks, and the like. Such a ship would not be impervious to every conceivable enemy attack, of course, but it would not be helpless or doomed to an early sinking.

Benefiting from the robust and continual support provided by their base ships, SLB FOLs and hides will be modestly sized and equipped. Hide bases, for example, would field only the personnel needed to park, inspect, and service aircraft; rest and feed air crews; offer a command and communications node; and ensure security. FOLs will perform these functions and operate expeditionary fuel systems. Based on these limited requirements and informal discussions with expeditionary-experienced Air Force and Marine logisticians, one would reasonably presume that the support echelons at a typical FOL would involve

150–200 personnel and about 30 vehicles while a hide would involve 80–100 service members and about a dozen vehicles. These numbers would vary at the margins in reflection of the security environment and the availability of host-nation civil contract and military support. The air command and operational support echelons on ship probably would fall in the realm of 250–350 personnel. Thus, an SLB unit supporting 12–20 tankers at an FOL and two hides would include about 700–900 personnel as well as the ship's company. Of course, most support and operational personnel and most assets would be drawn from the Air Force's existing air refueling force.[27] Only the ship and its crew would be additive to existing Maritime Administration or Navy programs, depending on how they were operated.

FOLs and hides, therefore, would not present the usual picture associated with an Air Force expeditionary air refueling base: rows of aircraft in predictable locations, acres of concrete, a busy traffic pattern, fuel-tank farms, cantonment areas, and so on. Instead, the typical SLB location would look like an ordinary civil airport with the addition of a few scattered military elements. Depending on the daily utilization rate of the aircraft (the percentage of time spent in the air) and the number of dispersal bases utilized, the number of tankers parked around a given airfield might range from a half dozen to only one or two. Fairly often, tugs would be seen towing an aircraft among widely scattered parking spots, many of them perhaps off concrete. Clusters of fuel-bladder tanks would occupy well-separated locations on and off the field. They would be contained by the only substantial engineering project required to open an FOL—soil berms bulldozed up by military civil engineers or civil contractors a day or two before the base ship arrived offshore. In the likely absence of an underground fuel hydrant system, aircraft would taxi or be towed to scattered surface hydrants connected at a safe distance from the bladder system. The cantonment and trailer-mounted support facilities might or might not even be on the field, and the latter would be relocated routinely. The only other indications that a military operation was under way would include a visible presence of local soldiers and vehicles in the environs of the field, joint patrols of host-nation and US security personnel within the airfield, and the fairly unobtrusive comings and goings of US vehicles. Such minimalist and transitory facilities certainly could and would be detected episodically by enemy air, space, and human ISR components. Looking at the photographs or reading reports, however, enemy intelligence interpreters would be hard pressed to know if the Americans had just arrived or had been there for a couple of days and might have departed already.

Aircraft

Given the criticality of basing agility during operations in the missile ring, the selection of an aircraft best suited for SLB operations will reflect a different *balance* of performance criteria than for other Air Force air refueling missions. Heretofore, Air Force tanker aircraft acquisitions have been predicated on the availability of developed bases and a preeminent emphasis on range and offload capacity. Consequently, all Air Force core tankers, except those purchased to support SOF and helicopter operations, have been modified airliner designs. As long as adequate airfields are available, these aircraft have been the most cost-effective platforms for delivering fuel over long distances. Aircraft designs best suited to exploit SLB, in contrast, would trade some range/payload efficiency for enhanced capacity to operate from less-developed airfields. As the following figure indicates, tanker aircraft capable of operating from austere airfields could disperse more widely than airliner-derived designs and operate further forward—with good effects on their survivability and off-load capacities at their points of need. It may also be useful, as the Marines have done with their KC-130 fleet, to consider the secondary airlift and other uses of aircraft matched to the SLB mission.[28] The austere airfield characteristics of these aircraft would fit them well for logistics operations and for support of maneuvering land forces as well as combat air units operating at forward locations or at main bases with damaged runways or limited parking areas.

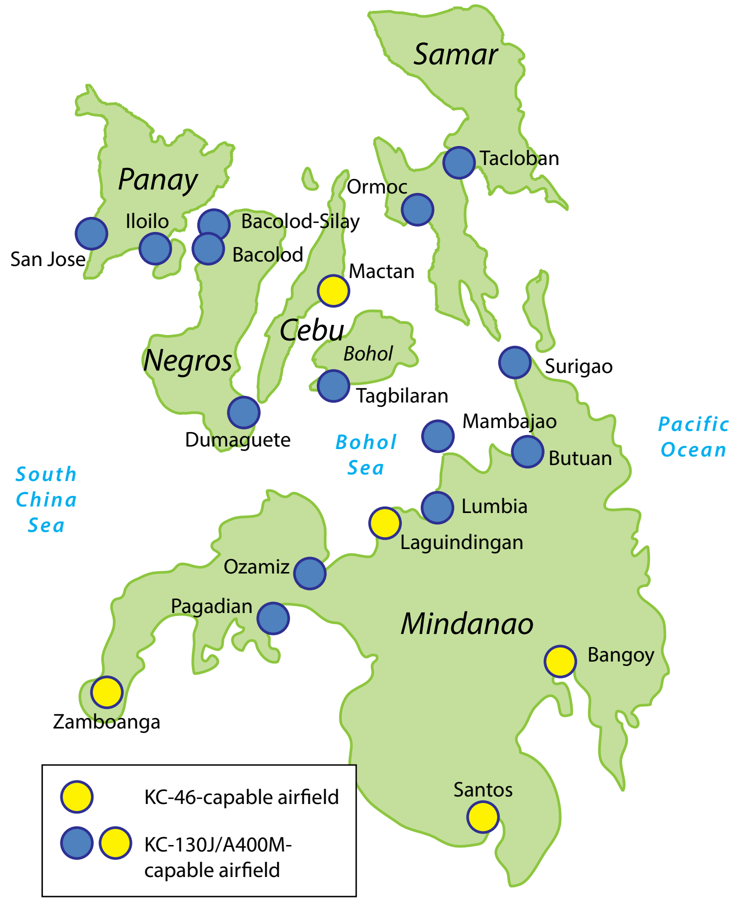

Figure. Airfields in the southern Philippines capable of accommodating KC-46s (yellow) and KC-130s/A400Ms (yellow and blue). Importantly, all are located near—sometimes within yards of—waters navigable by a base support ship and/or its amphibious craft.

At present, the field of aircraft available for comparison as SLB platforms is limited to the Boeing KC-46A, Lockheed KC-130J, and Airbus A400M. Other platforms could be considered, including the US Air Force's current KC-10s, KC-135s, more modern airliner designs, and the Embraer Corporation's developmental KC-390. Nevertheless, this study passes over these aircraft as offering few or no advantages over KC-46s or as being too old (KC-135s) or limited in numbers (KC-10s).

The KC-390 will offer an interesting option for smaller air forces, but it has no performance advantages over the KC-130, apart from speed, to justify its augmentation into the US fleet. For a number of reasons, then, the only aircraft worthy of serious consideration for SLB are the current mainstays of the Defense Department's air refueling modernization programs (the KC-46A and KC-130J) and an in-production international design falling between them in size and general capabilities (the A400M).

The KC-46

An airliner-derived design, the KC-46 is the most productive of the aircraft under consideration in terms of off-load/range performance and the one most *limited* in its access to regional airfields. As indicated in table 2, the KC-46 is designed for long-range, high-capacity operations.[29] Depending on airfield altitude and aircraft weight, however, KC-46s typically will demand hard-surface runways of 7,000–10,000 feet in length as well as hard-surface parking areas.[30] Although airfields of suitable length for KC-46 operations are available in most regions of the world, they are limited in number, and their paved parking areas tend to be sized for just a few large aircraft. Thus, almost anywhere they might be employed, SLB-supported KC-46 units will remain constrained in their ability to employ agile disaggregation among bases and dynamic dispersal upon them. In other words, they will prove more vulnerable to early detection, preplanned attacks, and even blind shots than will aircraft with more agile operational characteristics on the ground.

Table 2. Fuel off-load capacity at varying operational radii (pounds x 1,000)
(presumes round-trip transit, two hours on station, and one hour reserve fuel)

Radius of action (nm)	*0 (capacity)*	*500*	*750*	*1,000*	*1,250*	*1,750*
C-130J	82	51	44	36	28	12
A400M	138	89	77	66	55	32
KC-46A	207	155	144	134	122	110

Able to carry up to 18 standard cargo pallets, the KC-46 does offer significant bulk airlift capabilities. Its airliner cabin, though, has neither the dimensions nor strength to accommodate armored combat vehicles or pallets loaded to exploit the full height of C-5 and C-17 aircraft. These characteristics would undermine or eliminate the usefulness of the aircraft in support of movements by mechanized ground forces and air defense missile units, the resupply of forward airfields damaged by enemy attacks, or interfaces with type-designed military airlifters moving combat relevant cargos further forward.

The KC-130J

From the perspective of SLB, the KC-130J is a mirror image of the KC-46: it offers strong potential for agile basing coupled with modest range/off-load characteristics (see table 2). Perhaps the most obvious attribute of KC-130Js in this role is their ability to operate from weakly paved or even unpaved runways and parking areas. Fully loaded, they can land and take off from runways 3,000–4,000 feet in length, using assault takeoff procedures, or about 5,000–6,000 feet, using normal (and safer) procedures. Moreover, they can taxi or be towed onto unpaved surfaces, greatly increasing the parking areas available to them at many airfields. Consequently able to operate from a wider number of airfields and to frequently relocate assets on them, an SLB force based on the KC-130J would present an unpredictable and generally unremunerative target set for short-supply, high-cost A2/AD weaponry.

Within the limits of the aircraft's capabilities, SLB can mitigate the operational handicaps of the KC-130's modest range/off-load performance, equipage for probe-and-drogue refueling operations only, and small size. Indeed, its effectiveness over the vast distances of a theater like the Asia-Pacific would hinge on forward basing, preferably with the agility and resilience provided by SLB. Further, an SLB probe-and-drogue tanker force would offer value to overall theater air refueling efforts by providing more efficient support to Navy and Marine aircraft operating from bases and aircraft carriers outside the missile ring. Doing so would permit theater air commanders to focus boom-equipped tanker aircraft on supporting Air Force planes.

In contrast, SLB would offer only modest and indirect improvements to the KC-130's limited cargo capabilities. Sea-land bases doubling as KC-130 forward refueling points could increase the range and efficiency of their cargo operations. Nevertheless, the aircraft's modest speed and cargo "box" size will restrict its primary roles to transporting passengers, palletized cargo, and the light equipment of tactical air units. Otherwise, it cannot load combat-configured, medium-weight, armored fighting vehicles and, consequently, has only limited ability to support movements by mechanized units or air defense forces. Similarly, even though it could operate on and around damaged runways and ground-movement areas, a C-130 fleet likely would be hard pressed to deliver the cargo tonnages needed to keep major bases operating in the face of persistent A2/AD attacks.[31]

The A400M

Despite—or perhaps because of—its international pedigree, the A400M offers performance compatibilities worthy of serious consideration by US planners (see table 2). Operationally, it can utilize virtually the same runways and parking areas as the KC-130J but with markedly better characteristics of range/off-load, speed, and cargo capacity. Depending on range, the A400M will deliver from two to three times more fuel to receiver aircraft than the KC-130J. It is significantly smaller than the KC-46A, but in the context of SLB, the A400M can offset its relative limitations through forward basing. For example, in the scenario of supporting a refueling orbit 250 nm west of Manila, a KC-46 operating from Tinian would have 113,000 pounds of fuel available for off-load while an A400M operating from Tacloban would offer about 90,000 pounds. Moreover, the KC-46 would burn about 100,000 pounds of fuel performing its mission—a ratio of about .88 burn/off-load. The A400M, meanwhile, would consume 48,000 pounds for a .53 burn/off-load ratio. Depending on operational circumstances, then, an SLB fleet element of A400Ms could greatly reduce the logistical costs and fuel infrastructures required to support combat operations. Once again, the aircraft's probe-and-drogue capabilities would limit it to the support of Navy and Marine Corps aircraft, but it generally would do so more effectively than KC-130Js and with significantly improved flexibility and resilience over KC-46s.

Finally, the aircraft's large cargo box and 41-ton cargo capacity would make it a better airlift partner to the C-5/C-17 fleet than either of the currently programmed tankers. At the moment, Air Force and Army planners contemplating movements into austere airfields confront the reality that C-130s can get into a wide range of airfields but can carry comparatively little while C-17s carry much more but also rut, gouge, and otherwise render unpaved surfaces unusable after only a few passes.[32] A fleet element of flex-role A400s could fill that gap. They could provide substantial lift over strategic and tactical distances in support of main air bases degraded by enemy attacks; furthermore, they could deliver combat-relevant mechanized, engineering, and air defense units closer to their points of need than any aircraft or combination of aircraft in the Air Force program-of-record fleet.

Recommendations

This study set out to encourage the Air Force to take a serious look at a variation of sea basing for air refueling forces in the face of substantial A2/AD threats. The article's discussion of the nature of China's capabilities in this realm suggested that even a robust A2/AD system presents opportunities to operate air refueling forces at forward air bases as long as their tactics include agile disaggregation *among* airfields and dynamic dispersal *upon* airfields. By assessing historical and existing sea-basing concepts, it also made the point that SLB likely will prove viable both operationally and logistically. Finally, the discussion of aircraft suggested that the air refueling program of record likely would benefit from the addition of a platform better able than those currently in the fleet to fully exploit SLB. As an example, the article noted that a modest fleet of A400Ms would increase the number of bases available for air refueling operations, optimize the operational opportunities presented by SLB, and provide valuable augmentation to the airlift fleet. The costs of such an aircraft could be offset by earlier retirements of geriatric KC-135 and aging C-130H aircraft, and by reduced purchases of other tankers following the current KC-46A program. Taken together these considerations of conceptual viability, capabilities of alternative aircraft, and the availability of cost offsets suggest that the Air Force would do well to carefully examine and test SLB with an eye toward achieving initial operational capability in the four-to-six-year midterm.

Accordingly, the Air Force should initiate an aggressive study-and-test program for SLB in the near term. By the end of 2017, that program should have completed at least the following analytical elements:

1. Assessment of SLB in the context of joint war plans, service operational concepts, and predictions of potential A2/AD threats.
2. Examination of SLB in the context of the full range of tanker aircraft missions. For example, the integration of tankers and fighter aircraft at unpredictable and rapidly changing forward operating locations could greatly improve the ability of air commanders to (a) maintain rotations of aircraft in defensive counterair orbits, (b) support large gorilla strike surges, and (c) maintain forward alert forces to reinforce aircraft in airborne barrier patrols in the event of large-scale enemy attacks.

3. Creation of a whole-of-concept blueprint of the operational, logistical, command and control, and other issues relevant to the effectiveness and resilience of SLB units.

4. An initial field test of the concept using existing C-130 and/or KC-135 aircraft. Initially, these tests could be conducted on land by "FOL," "hide," and "ship" components under rules that simulate the distance, restricted facilities, and logistics of sea-land operations. As soon as possible, however, the Air Force should partner with the Navy to try the concept with an actual ship base.

5. Examination of the applicability of SLB to other Air Force missions, particularly fighter FOLs, ISR, and SOF.

These analytical efforts could be undertaken quickly and cost effectively by a combination of in-house study centers, contract research organizations, well-directed interservice groups of war and staff college students, and service test organizations. Given the threats resident in the Asia-Pacific and elsewhere, it will be important to see if the time-proven concept of blending sea- and land-base elements still has currency in the A2/AD world. ✪

Notes

1. Resilience is the ability to withstand attack, adapt, and perform military operations in the face of continued enemy assaults.

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5. "The Logistical Impact of Seabasing," Second Line of Defense, accessed 20 July 2014, http://www.sldinfo.com/the-logistical-impact-of-seabasing/. This article includes an interview with Marine colonel Bradley Weisz, deputy commander of Expeditionary Strike Group Two, who participated in exercise Bold Alligator 2012. See also Colonel Weisz, "The Bold Alligator 2012 Approach," Vimeo, video, 04:54, accessed 21 July 2014, http://vimeo.com/35058483. For similar US Army tests, see Marcus Weisgerber and Paul McLeary, "US

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7. Capt Charles Walker, USN, retired, to the author, e-mail, 22 June 2014.

8. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014* [hereafter *Annual Report 2014*] (Washington, DC: Department of Defense, April 2014), 30, http://www.defense.gov/pubs/2014_DoD_China_Report.pdf.

9. Department of Defense, *Annual Report to Congress: Military Power of the People's Republic of China 2007* (Washington, DC: Department of Defense, May 2007), 17, http://www.defense.gov/pubs/pdfs/070523-China-Military-Power-final.pdf; and Roger Cliff et al., *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Santa Monica, CA: RAND, 2007), 60–62, http://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf.

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11. Department of Defense, *Annual Report 2014*, 7, 27, and throughout; Mark A. Stokes and Ian Easton, *Evolving Aerospace Trends in the Asia Pacific Region: Implications for Stability in the Taiwan Strait and Beyond* (Washington, DC: Project 2049 Institute, 2010), 12–13, http://project2049.net/documents/aerospace_trends_asia_pacific_region_stokes_easton.pdf; and Jonathan F. Solomon, "Defending the Fleet from China's Anti-ship Ballistic Missiles: Naval Deception's Roles in Sea-Based Missile Defense" (master's thesis, Georgetown University, 15 April 2011), 25.

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15. Cliff et al., *Entering the Dragon's Lair*, 99.

16. For insights into China's uncertain and contradictory approach to modernized command and control, see Zhao Shengnan, "New Joint Command System on Way," *China Daily*, 3 January 2014, http://usa.chinadaily.com.cn/china/2014-01/03/content_17212780.htm; and the military's quick rebuttal in Bai Tiantian and Liu Yang, "No Joint Command: MOD," *Global Times*, 6 January 2014, http://www.globaltimes.cn/content/835937.shtml. For analysis of the situation, see James Mulvenon, "Rearranging the Deck Chairs on the *Liaoning*? The PLA Once Again Considers Reorganization," *China Leadership Monitor* 43 (Spring 2014),

http://www.hoover.org/research/rearranging-deck-chairs-liaoning-pla-once-again-considers-reorganization.

17. Shai Oster, "President Xi's Anti-corruption Campaign Biggest Since Mao," *Bloomberg*, 4 March 2014, http://www.bloomberg.com/news/2014-03-03/china-s-xi-broadens-graft-crackdown-to-boost-influence.html.

18. Department of Defense, *Annual Report 2014*, 32.

19. Reliable data on the likely performance specifications of China's probable next-generation fighters is not available in unclassified documents. However, this analysis presumes that their range with strike-configuration weapons loads will be roughly equivalent to that of late-model F-16s and F-18s, which fall in the 350–450 nm window.

20. Department of Defense, *Annual Report 2014*, 85.

21. For useful discussion of access issues, see Bowie, *Anti-access Threat*, 33–36.

22. This was exactly the case prevailing during the conflict between NATO and Libya in 2011. Even among southern Europe's many airports, the number of KC-135-capable runways (about 10,000 feet in length) was limited, and they were either unavailable civilian airports or their limited ramp spaces were filled by combat aircraft. Consequently, the productivity of the small air refueling force available was undermined by the necessity of operating from Moron, Spain; Istres, France; and other bases even further away from Libya.

23. Given the public unavailability of nonproprietary information on the KC-46's expected range/off-load characteristics, this data is a product of integration and interpretation of data from several sources, including the following: Boeing, "767 Airplane Characteristics for Airport Planning," September 2005, http://www.boeing.com/assets/pdf/commercial/airports/acaps/767.pdf; Air Force Pamphlet 10-1403, *Air Mobility Planning Factors*, 12 December 2011, http://static.e-publishing.af.mil/production/1/af_a3_5/publication/afpam10-1403/afpam10-1403.pdf; and "Boeing 767-300ER," in *Jane's All the World's Aircraft, 2012–13*, ed. Paul Jackson (London: HIS Global, 2012), 998. This data, therefore, is reasonably accurate but not definitive. Basic presumptions include 207,000 pounds of transferable fuel, 10,000 pounds/hour burn rate, and 460-knot cruise. The KC-130 data is based on C-130J air refueling performance information provided by HQMC Aviation Division, APP-5 (Plans, Concepts and Integration), to the author, e-mail, 13 June 2014. Basic presumptions include 83,000 pounds of transferable fuel (tanker configuration), 5,000/hour burn rate, and 320-knot cruise.

24. In combination the Tactical Airfield Fuel Dispensing System and Amphibious Assault Fuel System consist of about 300 tons of equipment, providing bladder-bag storage for 1.4 million gallons of fuel. Setting up the entire system would require around a dozen individuals working for about four days. However, a more limited capability could be set up in much less time. The long pole in the process is building the earth berms necessary to contain fuel spills or fires. See data sheets provided by the Marine Corps System Command: "Tactical Airfield Fuel Dispensing System (TAFDS)," accessed 5 August 2014, http://www.marcorsyscom.marines.mil/Portals/105/pdmeps/docs/FUEL/B0675.pdf; and "Amphibious Assault Fuel System (AAFS)," accessed 5 August 2014, http://www.marcorsyscom.marines.mil/Portals/105/pdmeps/docs/FUEL/B0685.pdf. See also US Army 10th Transportation Battalion (Terminal), "PHIB SEABEE BATTLEBOOK," 6 February 1998, 16–17, http://www.fas.org/man/dod-101/sys/ship/docs/phibcb-battle.htm; David Willoughby, "Fueling for Today's U.S. Military," Petroleum Equipment and Technology Archive, September 1997, http://www.petrolplaza.com/technology/articles/MiZlbiYxMDIzMSYzJjEmMiYm; and Lance Cpl Keenan Zelazoski, "Bulk Fuel Company Demonstrates Capabilities of Amphibious Assault

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25. John Reardon, US Maritime Administration, Division of Sealift Operations and Emergency Response, datasheet provided to author, 25 May 2014.

26. Notably, the $60 million refurbishment did not include replacement of the ship's engines or upgrades to its defensive systems. "LPD 4 Austin class," Federation of American Scientists, accessed 26 February 2014, http://www.fas.org/man/dod-101/sys/ship/lpd-4.htm; and Robert Johnson, "America Has Never Had a Ship Like the USS Ponce," *Business Insider*, 23 September 2012, http://www.businessinsider.com/photos-uss-ponce-012-9?op=1.

27. These personnel and resources estimates are tentative and approximate, of course. They represent a series of roundtable, telephonic, and e-mail discussions by the author with logistics experts in Air Mobility Command; the 6th Air Mobility Wing at MacDill AFB, FL; Headquarters US Marine Corps; and Headquarters Marine Forces Pacific during June and July 2014.

28. James K. Sanborn, "Corps Pins Its Future on the Multi-mission KC-130J Super Hercules," *Marine Corps Times,* 19 May 2014, http://www.marinecorpstimes.com/article/20140519/NEWS/305190028/Corps-pins-its-future-multi-mission-KC-130J-Super-Hercules.

29. Regarding the C-130J, see note 23 (KC-130 data). Basic presumptions include 83,000 pounds of transferable fuel (tanker configuration), 5,000/hour burn rate, and 320-knot cruise. Information for the A400M is based on extrapolations of data provided in EADS North America briefings: *All* A400Ms Are Tanker and Receiver Capable (2014); and A400M: Combat Delivery to Point of Need (2013). Basic presumptions include 9,000 pounds/hour fuel burn rate, 400-knot cruise. Regarding the KC-46A, see note 23. Basic presumptions include 10,000 pounds/hour fuel burn rate and 460-knot cruise.

30. See note 23.

31. Robert C. Owen, "Theater Airlift Modernization: Options for Closing the Gap," *Joint Force Quarterly* 75 (4th Quarter 2014): 13–18, http://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-75/jfq-75.pdf.

32. For discussions of C-17 and C-130 effects on soft fields, see Air Force Civil Engineer Support Agency, "Engineering Technical Letter 97-9: Criteria and Guidance for C-17 Contingency and Training Operations on Semi-Prepared Airfields," 25 November 1997, 10, https://www.wbdg.org/ccb/AF/AFETL/etl_97_9.pdf; and Lockheed Martin Corporation, *C-130J Super Hercules: Whatever the Situation, We'll Be There* ([Bethesda, MD: Lockheed Martin,] n.d.), 18.

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