A Range-Balanced Force

An Alternate Force Structure Adapted to New Defense Priorities

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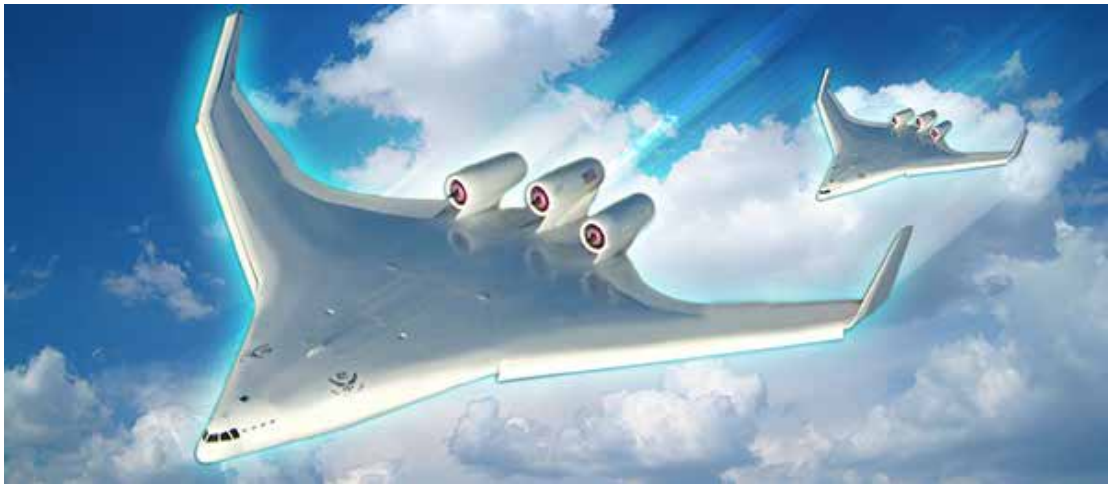

This article argues that external forces will drive the US Air Force to procure a very different force structure than the one currently postulated for the early 2030s. Specifically, the service will eventually settle on a structure for its combat air forces (CAF) dominated by longer-range strike platforms capable of remotely piloted operations—a "range-balanced force." The first section of the article describes the future environment and challenges that will shape the force structure. The second presents a range-balanced force better configured to meet these issues. The final section discusses how the Air Force might transition to the new force structure.

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Many people believe that they can fairly well estimate the service's structure for the 2030s by looking at today's program force-extended. Although most expect some trimming of the overall numbers due to austere times, few think that the force structure will deviate markedly from a fleet dominated by manned, short-range fighters in general and the F-35 specifically, with well below 10 percent of the total fleet composed of bombers. According to this analysis, that future is very unlikely.

A convergence of significant forces will drive the Air Force to a different force structure, one similar to a range-balanced force outlined below. This argument is not prescriptive; rather, it proposes an alignment of forces that will take the service down a different acquisitions path. Beyond buying more long-range-strike bombers (LRS-B), these forces will likely feature two aircraft types not currently contemplated in Air Force budgets—a medium-range unmanned combat aerial vehicle (UCAV) and a long-range, optionally manned, general-purpose, blended-wing body (BWB) with a bomber variant. Should this be the shape of things to come, Airmen should embrace it now.

The Strategic Environment and Converging Forces of Change

A number of important factors will conspire to ensure that the Air Force's force structure of the future emphasizes long-range strike and autonomous capability in spite of internal resistance.[1] These include the following: a change in strategic guidance emphasizing antiaccess/area-denial threats and a rebalance toward the Asia-Pacific; the requirement to project power across the Asia-Pacific's vast distances; the public expectation of increased use of autonomous technology and the rise of a community of remotely piloted operators in the Air Force; the criticality of maintaining America's competitive advantage in its high-tech / air and space industrial base in the face of rising in-

ternational competition; the Air Force's need to maintain value in the national security establishment to both cooperate and compete with the other services by maintaining its ability to control and exploit the air and space domains; and the Air Force's natural bureaucratic desire as an organization to protect its identity as a separate service and its freedom of action.

As a military service subordinate to civilian leadership and its direction, the Air Force sees the change in strategic guidance articulated in *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* as one of the most compelling forces acting upon it to revise its acquisition strategy. According to the new guidance, "*The U.S. military will invest as required to ensure its ability to operate effectively in anti-access and area denial . . . environments*. This will include implementing the Joint Operational Access Concept, . . . developing a new stealth bomber, [and] improving missile defenses. . . . While the U.S. military will continue to contribute to security globally, *we will of necessity rebalance toward the Asia-Pacific region*" (emphases in original).[2] As illustrated in figure 1, these expanding environments feature significant ballistic and cruise missile threats that put at risk close-in bases, carriers, tankers, and other high-value assets which underpin our fighter-heavy strike forces. In such environments, the Air Force must supply a "halt-hold" force at the highest end of the spectrum of warfare in theaters characterized by few air bases—all under missile threat.

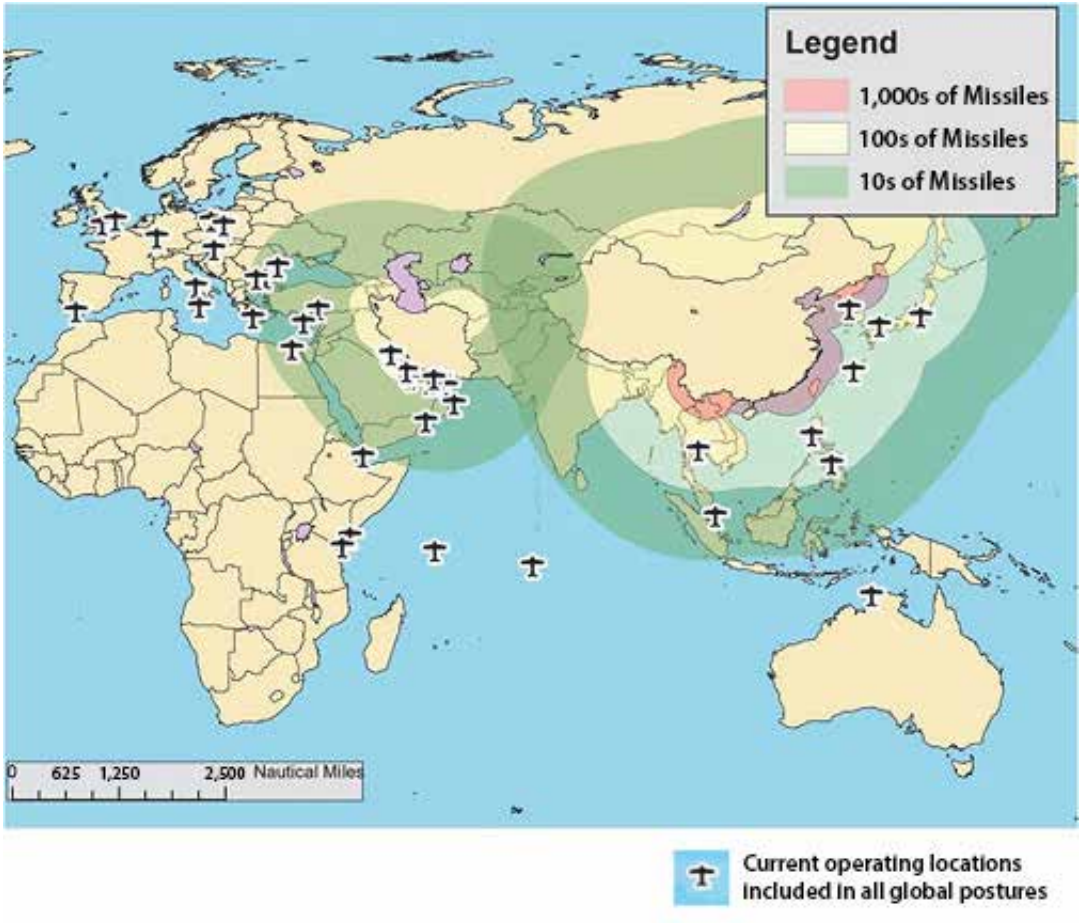

Figure 1. Iranian and Chinese missile threat, 2011. (From Lynn E. Davis et al., *U.S. Overseas Military Presence: What Are the Strategic Choices?* [Santa Monica, CA: RAND, 2012], fig. 3.1, p. 21, http://www.rand.org/content/dam/rand/pubs/monographs/2012/RAND_MG1211.pdf. Reprinted with permission.)

To remain relevant, the service will need a force structure that gives the United States a definite asymmetric advantage—the ability to function from long range. Individuals who make resourcing decisions will likely see the programmed structure—characterized by some 1,700 F-35s with a combat radius of barely 600 nautical miles (nm) unrefueled and only 100 LRS-Bs (despite their much greater range and payload)—as mismatched to the operational problems.[3]

The dangers articulated in the new defense strategic guidance are not considered principally land threats calling for a large, mobilized army. Further, the United States' airpower and industrial base can supply the necessary speed of response and overmatch to deter threats; threaten escalation; and flexibly engage, disengage, and impose costs. Consequently, the Air Force is in a strong position to argue for resources in preference to the other services. Under these conditions, resources would exist for new systems considered important, but we cannot expect the Department of Defense's (DOD) total "top line" to trend upward in our favor.[4] As occurred in the 1950s, the increase in the Air Force's top line will have to come from internal savings and funds taken from the other services, particularly the active component of the Army.

Pressure to move toward remotely piloted / autonomous systems constitutes another notable force acting on the Air Force. On 21 September 2012, the deputy secretary of defense signed DOD Directive 3000.09, *Autonomy in Weapons Systems*, the result of an 18-month effort across the Office of the Secretary of Defense (OSD) and the services to create a responsible but enabling policy for acquisition and use of weapons systems "that, once activated, can select and engage targets without further intervention by a human operator."[5] Evidently, many members of the external policy community and public at large have "seen the future" and expect the Air Force to move with greater speed toward more remotely piloted / autonomous platforms.[6] Not everyone agrees, of course. Reports such as Human Rights Watch's *Losing Humanity: The Case against Killer Robots* highlight broader societal concerns that the tremendous speed of progress, proliferation, and employment of increasingly capable remotely piloted / autonomous systems might compromise our highest values: morality and responsibility in war.[7] But the report itself is evidence of society's expectation that future conflict will feature "drone warfare." Regardless of whether or not these beliefs are accurate now or in the future, a strong force of public sentiment and popular culture will likely create space for re-

motely piloted / autonomous alternatives not currently in the Air Force's inventory.

Nor is the pressure entirely domestic. As noted by Peter Singer, author of *Wired for War*, "This robotics revolution is not just an American revolution."[8] Moreover, the Government Accountability Office reported that "since 2005, the number of countries that acquired an unmanned aerial vehicle . . . system nearly doubled from about 40 to more than 75. In addition, countries of proliferation concern developed and fielded increasingly more sophisticated systems."[9]

This external pressure will only strengthen as defense analysts watch non–Air Force parties such as the Navy N-UCAS and the French Dassault nEURon UCAV, scheduled to fly in 2012, doing what they think America's cutting-edge Air Force is "supposed to do." That pressure includes the OSD. Many people believe that the Air Force is dragging its feet and that remotely piloted / autonomous platforms offer the nation the advantages of usability, lowered risk, and lowered cost. "It's been like pulling teeth," said former secretary of defense Robert Gates in April 2008.[10] One can see the OSD's strong support for remotely piloted / autonomous systems in the secretary's statement during the roll-out of the new defense strategic guidance: "Lastly, as we reduce the overall defense budget, we will protect, and in some cases increase, our investments in . . . new technologies like ISR [intelligence, surveillance, and reconnaissance] and unmanned systems."[11] The OSD matched its rhetoric by releasing its new directive on autonomy, creating an initiative, and finding resources to accelerate the Navy's Unmanned Carrier Launched Airborne Surveillance and Strike development program.[12]

Pressure will also come from inside. For the first time, the Air Force is buying more RPAs—the Air Force's current term and method of operating remotely piloted / autonomous aerial systems—than fighters and training more RPA operators than fighter pilots.[13] These operators now constitute a significant community comfortable with the technology and its employment—a community that will seek a voice in policy

and procurement. Given the conclusion of US combat operations in Iraq and the anticipated withdrawal from Afghanistan in 2014, the RPA community will naturally wish to adapt its technology and identity to high-end conflict. If not present already, a "critical mass" of RPA operators of ever-increasing rank will soon emerge within the Air Force, able to advocate internally for more investment in remotely piloted systems across the full spectrum of warfare.

The clear appreciation that our nation faces substantial challenges to its industrial competitiveness represents another critical external driver. The defense strategic guidance notes that the "Department will make every effort to maintain an adequate industrial base and our investment in science and technology."[14] The natural question for the military becomes, With regard to my national industrial base (and jobs and dual-use technology), what have you done for me lately? Aviation has been our best export industry and source of domestic innovation.[15] Its vibrancy and ability to produce the best systems worldwide underpin our military advantage and control of the air domain. But our industry confronts ever-stronger competition abroad, and our military acquisition's choices and timing of those choices will materially contribute to or detract from our nation's overall and long-term competitiveness across the entire aviation sector, as well as its ability to sustain our military advantage over the long term. Each service will have to demonstrate how investment in its deterrent posture improves the US position in the larger international market space and sustains the US economy by creating jobs at home. The latter is critical not only to maintaining our national aviation industrial-technical base but also to preserving congressional appropriations and support for Air Force modernization. A viable strategy links that modernization with US commercial industrial growth so that modernization enables and supports US competitiveness rather than detracts from it.

Threats to and solutions proposed by the Navy will also affect the Air Force's acquisitions. Carriers' vulnerability to the Chinese DF-21 missile highlights the Air Force's own vulnerability of short-range tacti-

cal air assets (stationed in the same theater) to similar threats. A decision by the Navy to purchase a long-legged, stealthy UCAV will certainly cause policy analysts, budget-waste cutters, and Congress to ask why the Air Force isn't buying the same platform.

The Air Force will also have to protect itself as an independent service. It cannot make these claims on the basis of tactical air-to-ground missions—only on its distinctive functions of long-range bombing and air superiority. Competence in tactical air-to-ground exists solidly in the Navy and Marine Corps and is proliferating via RPAs to the Army.

Long- and short-range aircraft are vulnerable to modern, highly capable surface-to-air missiles as well as enemy fighters and their supporting integrated air defense systems. The Air Force has attempted to mitigate this threat by modernizing to a fleet of fifth-generation fighters more survivable in this environment. Unfortunately, these highly capable fighters are critically dependent upon a system-of-systems that features a pair of Achilles' heels not easily remedied—tankers, which must be relatively close to the fight, and close-in air bases. Adversaries increasingly pursue "high value aircraft attack" capabilities and tactics to cripple our tankers and ISR. They can afford large numbers of ballistic and cruise missile systems to strike air bases and aircraft on the ground.

If one accepts supporting tankers and bases as the most vulnerable aspect of the manned-fighter system-of-systems, then a strategy of power projection based on an overcommitment to short-range manned fighters begins to appear less desirable. In general, a force structure overwhelmingly weighted toward a dual-role fighter-bomber is less adapted to the new defense priorities and likely inadequate. It imposes costs, risks, and issues because it forces the United States to operate from, build up, and defend bases inside the threat ring. Such a force structure comes with a substantial tanker bill, further elevating operational risk due to tanker vulnerability as high-payoff targets.

In an environment with the principal theater of concern characterized by significant distances, a greater mix of longer-range aircraft less

vulnerable to these Achilles' heels will probably seem more credible and usable than a force structure dominated by a short-range fighter-bomber with short legs, small payload, and inferior performance as an air superiority fighter, compared to the F-22. However, this analysis is not hostile to manned multirole fighters. Like the intercontinental ballistic missile leg of the triad, manned fighters and their close-in bases throw an adversary on the horns of a dilemma. That is, if he does not plan to eliminate them, then they remain available for use; if he plans to eliminate them, then defeating them entails considerable cost (they become more costly if bases feature hardened shelters that drive an adversary to use unitary warheads). Also, in all scenarios short of high-end war, manned fighters offer a flexible option to posture and signal resolve. Foreign sales provide independent, strategic opportunities for partnership building and its benefits.

Nevertheless, one can realize the above-mentioned costs to an adversary and the aforementioned strategic partnership and signaling benefits with a lower proportion of short-range assets. The remaining assets will likely enjoy greater survivability with a larger, highly credible long-range-strike force that makes preemptive attack upon close-in fighter bases appear futile and unattractive. All of these points will conspire to ensure that the future force structure of the Air Force puts more emphasis on long-range strike and remotely piloted capability. But what might this future force look like?

Basics of the Convergent Force Structure

Currently, the projected composition of the CAF is approximately 2,300 total aircraft, overwhelmingly dominated by F-35s (a total buy of 1,763), with less than one-tenth (currently projected as 6 percent) long range and less than one-fifth capable of remotely piloted / autonomous operation (fig. 2).[16] Planned RPA acquisitions are nonstealthy and unsurvivable in a nonpermissive or contested environment.

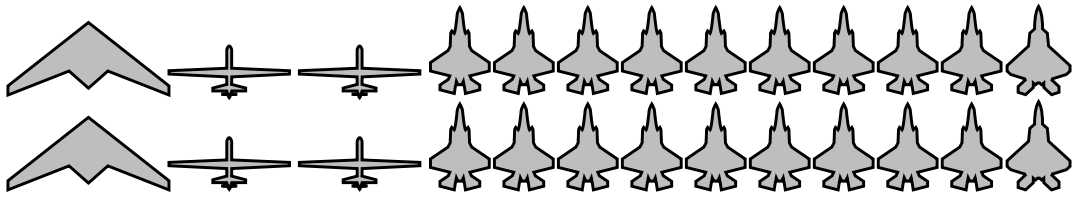

Figure 2. Rough approximation of basic elements of the program force-extended

A range-balanced force would seek to more evenly distribute the Air Force's investment among long-range (greater than 6,000 nm), medium-range (about 2,000 nm), and short-range (about 600 nm) aircraft (fig. 3). As a starting point, this analysis proposes a future force structure evenly distributed among one-third bombers, one-third medium-range UCAVs and one-third manned fighters, two-thirds of them capable of remotely piloted / autonomous operations. Figure 4 offers a visual representation of the approximate percentages of what such a force structure would look like, compared to the currently projected force in figure 2.

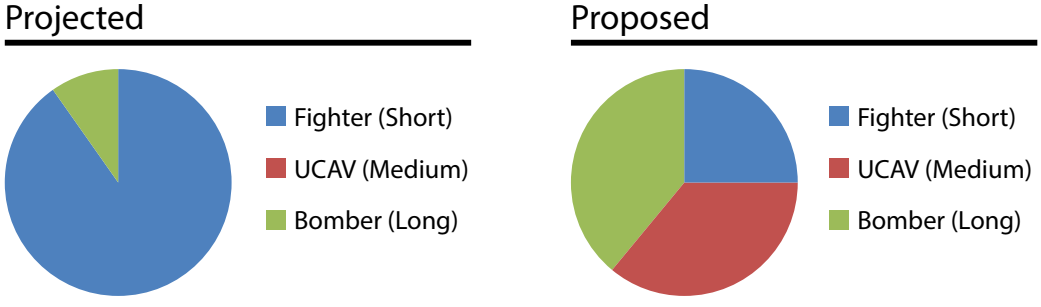

Figure 3. Ratios of range distribution

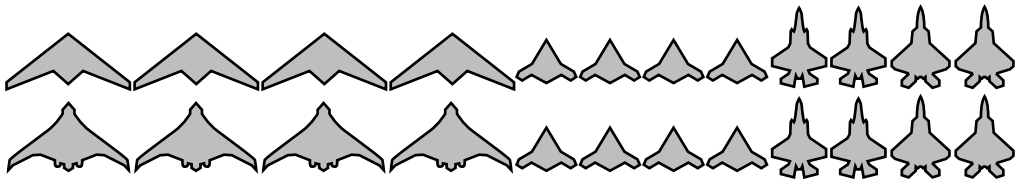

Figure 4. Proposed range-balanced force structure

This proposal involves a substantial reapportionment, creating a significantly more balanced force in terms of range. The change is quite dramatic: whereas the average unrefueled combat radius of the projected force is on the order of 814 nm, the range-balanced force boasts an average unrefueled combat radius closer to 2,208 nm.

The change in balance of manned versus remotely piloted/autonomous-capable systems is also noteworthy (fig. 5). The dominant feature of this new force is the "swing force" of a large number of medium-range (2,100 nm) UCAVs—probably X-47B descendants (fig. 6). An additional one-third of range-balanced forces consisting of optionally piloted long-range bombers would make fully two-thirds of the total CAF capable of remotely piloted / autonomous operations.

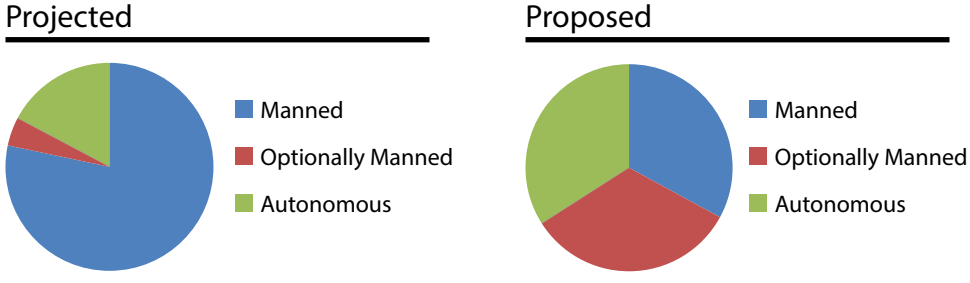

Figure 5. Manned versus remotely piloted / autonomous ratios

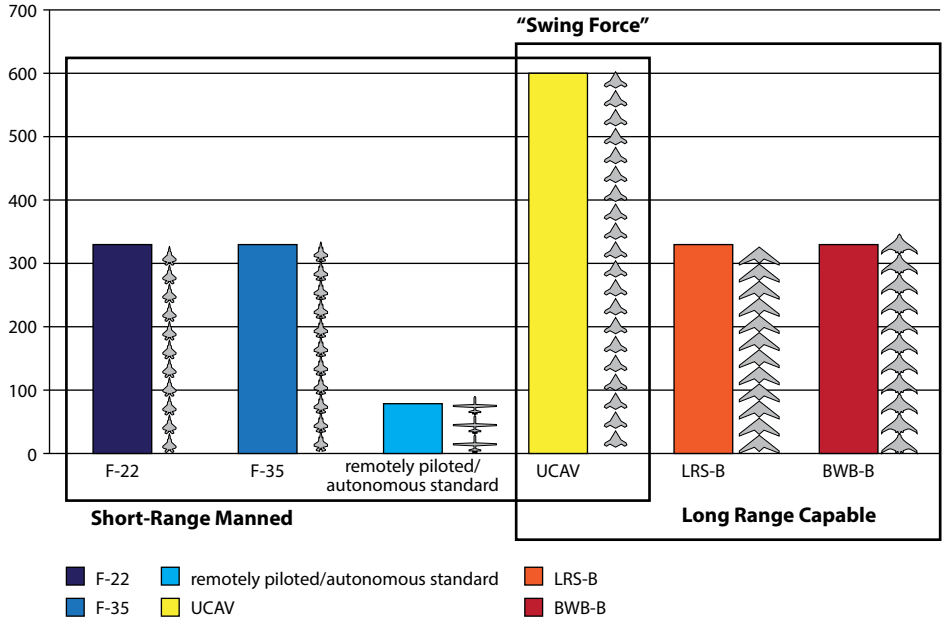

Figure 6. Range-balanced force structure at a glance

Longer-range aircraft are heavier and typically more expensive than other platforms. Assuming a relatively fixed Air Force acquisition budget or top line, an increase in the number of larger aircraft requires a slightly smaller total number of platforms procured. In this model, the CAF converges on 2,000 aircraft for its basic fleet (see fig. 6), with a composition in round numbers as follows:

- 330 F-22 Raptors
- 330 F-35s[17]
- 600 UCAVs (X-47B variant)
- 80 nonstealthy Reaper follow-ons
- 330 LRS-Bs
- 330 blended-wing-body bombers (BWB-B)

The exact numbers and proportions are not fixed, and within the basic structure of one-third long-range, one-third medium-range, and

one-third short-range/manned aircraft, one has room to innovate and explore other options. However the beauty of simple numbers lies in their ability to communicate clearly to external audiences, and the appeal of a balanced force like the one described above is its flexibility to adjust and respond to the environment as necessary.

Transition to the New Force Structure

Acquisition

Acquiring these platforms in 2020 and completing the transition to the convergent force by 2035 would essentially mean a national commitment of approximately $32 billion in annual acquisition of approximately 133 aircraft per year (44.4 fighters, 44.4 UCAVs, and 44.4 bombers).[18] This number is less than the most recent peak of 180 aircraft in 2008 and substantially above the current annual buy of only 59 in 2011. An annual procurement budget of $32 billion for the CAF seems reasonable and within historical precedents in light of the fact that the DOD's total aircraft procurement budget is now about $40 billion (including the CAF, mobility air force [MAF], and sister services), coming close to $70 billion in the mid-1980s (constant 2012 dollars).[19]

Is a 2,000-Aircraft CAF Sufficient?

One can make a basic argument for sufficiency based upon commonsense criteria and commonsense risk. The defense strategic guidance of 2012 observes that the force structure should prove sufficient to deter and prevail in one conflict and deny objectives or impose unacceptable losses in a second region.[20] Our starting assumption holds that our nation will be principally interested in a force that provides credible deterrence with minimum cost and the smallest deviation from existing budgets. Barring a crisis, the nation will operate on momentum, assuming that since we are not in a major war, its overall investment must be more or less right as long as procurement matches the stated priorities and objectives. America will easily see that a range-balanced

force will involve lower risk than one dependent for 90 percent of its combat power on a single short-range platform whose greatest vulnerability resides in the tankers, bases, and petroleum, oils, and lubricants facilities within the threat ring.

Since voters and many politicians will never have access to the complex models used by AF/A9 and OSD/CAPE, a number of them will make their evaluation based on open-source media and observable criteria.[21] The most obvious visible criterion involves examining the number of aircraft in our CAF, comparing it to that of potential challengers in each region, and making sure it is larger by some factor.

In this case, the Chinese People's Liberation Army Air Force is moving toward 1,700 combat aircraft in the 2020s with an expected composition of 500 Su-27s/30s, 500 F-10s, 300 F-7s/F-8s, 100 FC-1s/JC-17s, 250–300 ground-attack/long-range-strike platforms, and small numbers of its fifth-generation J-20.[22] Today, open-source documents estimate that Russia has approximately 1,800 combat aircraft (11 Su-35s, 16 Su-34s, 188 Mi-31s, 15 Su-30s, 226 Mi-29s, 281 Su-27s, 241 Su-25s, 639 Su-24s, 16 Tu-160s, 63 Tu-95s, and 117 Tu-22Ms).[23]

A range-balanced force of 2,000 aircraft (not counting the contribution of US allies) is appreciably more modern and at least 200 platforms larger than either the Russian or Chinese air force although smaller than both combined. Some individuals might consider this number inadequate since, as a global actor, the United States could face simultaneous contingency operations in more than one theater. The proposed force, however, is not obviously inadequate based on the simplest notion of mass of forces and certainly entails lower risk than the currently projected force, given its vulnerabilities and limitations. A range-balanced force gives policy makers the flexibility to determine if these numbers are sufficient, and five open weapons-systems production lines allow easy adjustment for increased production.

Affordability

Is such a radically different force affordable? A reasonable estimate suggests that it is. Assuming that aircraft cost scales with weight, a rough-order approximation derived by interpolating data suggests that the proposed force structure of 2,000 aircraft, composed of more platforms of larger size, admittedly increases costs by 15 percent over the projected force structure.[24] The major trade involves deep cuts to the overall number of F-35s to purchase a high number of UCAVs (approximately half the weight of the F-35) and fewer bombers of larger size.

Such a force would have significantly lower life-cycle costs—an unverifiable but certainly a plausible notion. Historically, the process of research, development, test, and evaluation (RDT&E) averages only 6 percent of such costs, and procurement only 28 percent. Operations and sustainment account for 66 percent of total life-cycle expenses for fixed-wing assets. The three largest categories include personnel (30 percent), fuel (17 percent), and base-level parts consumption (14 percent).[25] Since the range-balanced force appreciably increases the proportion of remotely piloted and optionally manned aircraft, some substantial portion of flying hours for currency training might be progressively reduced. As confidence in automation increases and specialization of the operators permits, the Air Force could move from an hours-based to a cycles-based maintenance construct and perhaps a lesser number of total pilots or pilots in the active component.

Depending upon the overall level of cuts, such a force structure might prove affordable within existing budget shares with internal trades. However, if the OSD and national security staff considered other Air Force programs vital and were unwilling to cut or reduce, trade-offs within the DOD as a whole might be more palatable. Assuming that this force structure better matches the strategic design of the president and secretary of defense, where might they realistically choose to make cuts or shift resources? Since the Navy and Marine Corps face the same issues, one could imagine a climate in which both the B and C variants of the Joint Strike Fighter were cancelled and re-

placed on a one-for-one basis with an X-47B-variant UCAV. Since cost scales with weight and the X-47B is almost exactly half the weight of the F-35, such a move would likely provide considerable savings and improve the Navy's relevance at strategic ranges while supplying more persistent air support for the Marine Corps.[26] However, the most obvious adjustment would involve reallocating shares of the defense budget between the Army and the Air Force.

Figure 7 illustrates how the services' shares of the budget (total obligation authority [TOA]) have shifted over time, giving a historical perspective to bound the likely possibilities. Notice that, almost as a rule, the Air Force's and Army's shares move in opposite directions—when one increases, normally the other decreases. At present, because of two decade-long occupations, the Army commands the largest budgetary share (35 percent), far above its average of about 25 percent and all-time low of 23 percent. Today, the Air Force finds itself at an all-time low (23 percent) compared to its average of about 30 percent. Actually, 23 percent overstates Air Force resourcing. A significant portion of the service's budget passes through for intelligence functions such as the National Reconnaissance Office, over which the Air Force has no control. "Air Force Blue TOA"—the budget over which the service has control—is actually only 18 percent of DOD TOA. When the Air Force was ascendant in the strategic design of the national security strategy, it commanded better than 30 percent (as high as 35 percent) in the 1980s and above 40 percent (as high as 47 percent) in the 1950s and 60s. One can imagine a natural inversion of budget shares, whereby 12 percent of the defense budget shares were transferred from the Army to the Air Force. Twelve percent is likely the upper limit of cuts to the Army in TOA share—a reasonable number, given both precedent and strategic design. The president and secretary of defense explicitly state that "U.S. forces will no longer be sized to conduct large-scale, prolonged stability operations."[27]

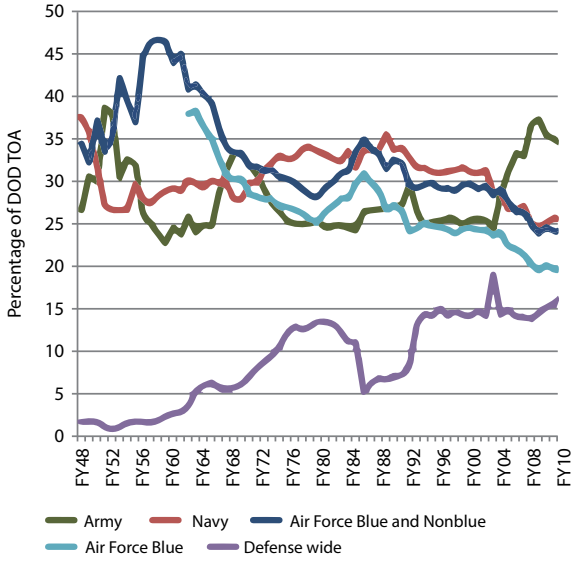

Figure 7. Service shares by total obligation authority. (From Briefing, Headquarters US Air Force Directorate of Strategic Plans and Programs, Washington, DC, derived from Office of the Under Secretary of Defense [Comptroller], *National Defense Budget Estimates for FY 2013* [Green Book] [Washington, DC: Office of the Under Secretary of Defense (Comptroller), March 2012]; Air Force Blue TOA: ABIDES 13PB and PFY files.)

Policy makers and DOD leadership might then decide to shift such a strategic capability to the Guard and Reserve. If the future security environment places a premium on mobility, then the same could be done with armor. The absolutely lowest limit for the active duty Army (excluding our commitments in Korea) might be an active force of 70,000 air-deployable light infantry—small teams similar to special operations forces and highly reliant on fires, mobility, command and control, and resupply from the air. Strategic planning would assume that such a force would not be expected to hold and occupy territory but to employ where friendly ground forces are present.

Advantages of the Convergent Force

A force so composed would have notable advantages over our current one. First, it represents a successful adaptation to concerns about the

Western Pacific / South China Sea, the Middle East / Arabian Gulf, and the vaster distances of the Indo-Pacific. Second, the substantial swing force of UCAVs allows operation in both penetrating air-to-ground strike and manned-autonomous teaming for air superiority, where it can serve as an off-board sensor and missile-carrying platform ("missile truck") for cooperative engagement. Such a concept of operations can rely on hard-to-jam line-of-sight low probability of intercept / low probability of detection data links and passive sensors rather than satellite communications. This ability of an autonomous system to serve as a "loyal wingman"—to operate seamlessly as part of a manned formation or strike package—provides a significant force multiplier for the manned fleet (fig. 8).[28]

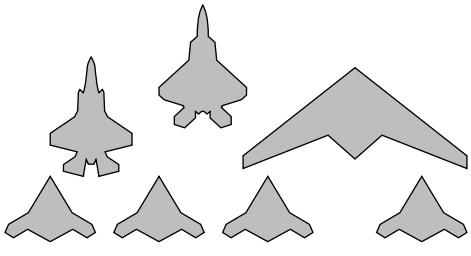

Figure 8. Manned–remotely piloted teaming or "loyal wingman"

Common purchase of the RPA platform by the Air Force and Navy would present new en route carrier-based staging concepts, reducing the complexity of setting up an air bridge in theaters dominated by water. The fact that a carrier-capable RPA requires sturdier landing gear would modestly degrade the ultimate range/payload, but the enhanced flexibility and other efficiencies in training and maintenance costs would make such an accommodation worthwhile. The probable high costs of RDT&E might also put the Air Force in a favorable position to influence the Navy's procurement decision, ensuring a better platform for the nation.

Third, inclusion of a less stealthy (but potentially quite survivable) BWB-B will measurably advance American aviation, probably allowing it to dominate commercial platforms for several decades. The BWB-B

could piggyback on the National Aeronautics and Space Administration's (NASA) environmentally responsible aircraft (ERA) (fig. 9). The ERA seeks to build an optionally manned BWB cargo/airliner with double the range/fuel economy over current tube and wing designs at a size entirely consonant with a long-range bomber.[29] This project would advance the BWB airframe, structures, material, engine technology, and optionally manned technology as well as provide an indirect subsidy of our commercial airline business. The latter, in turn, will mean lower costs for the Air Force.[30] Pursued in collaboration with the ERA, a BWB-B would also serve as an industrial-base catalyst similar to previous projects. The latter included the 707 airframe, which offered utility both commercially and as a widely modified military variant, and the C-5 competition, which gave birth to the turbofan and modern wide-body intercontinental aviation for passengers and cargo. An ERA/BWB-B collaboration would also advance the Air Force's autonomous/RPA goals since the target design of the ERA is nearly identical to that of the MQ-L concept articulated in the service's *Unmanned Aircraft Systems Flight Plan*.[31] The MQ-L is the Air Force's vision of a large platform "leveraging autonomous, modular and open architecture technologies. The MQ-L will be capable of performing today's manned heavy aircraft missions with one common core airframe."[32] Conceptually closest to a B-52 replacement, the MQ-L, available in the 2020s, is an easily modifiable, flexible platform or "truck" capable of "air mobility, airlift, air refueling, [electronic warfare], [multiple intelligence] ISR, strategic attack, global strike, [close air support], air interdiction and humanitarian assistance operations."[33] Pursuit of an optionally manned BWB-B/MQ-L presents opportunities for a different hedge for survivability, relying more on electronic warfare and directed-energy self-defense.

Figure 9. NASA's environmentally responsible aircraft concept. (Reprinted with permission from NASA.)

Fourth, the proposed force structure offers improved flexibility. The grounding of any one platform due to a serious maintenance problem or vulnerability does not compromise the capability of the overall force in either air-to-air or air-to-ground combat. Having "loyal wingmen" and optional manning greatly increases the resilience of the force to attacks on connective data links. Further, there is no reason why bomber platforms could not also have an air-to-air role, serving as off-board missile carriers (holding many more "long-stick" [long-range] air-to-air missiles and relying on off-board cueing), standoff jammers (with much larger apertures and power), or users of directed energy for offensive counterair. The logical conclusion is that a more balanced force permits simple adjustment, depending on how the operational picture changes, and easily allows the Air Force to flex incrementally in one direction or the other to optimize the force.

Fifth, the heavy proportion of optionally manned LRS-B and BWB-B platforms greatly expands flexibility for how the service grows and manages pilots and crews. If done properly, fundamentals pioneered for the optionally manned LRS-B system (quad-redundant flight con-

trols, mission-management systems, environmental systems, redundant communications, cockpit displays, and control stations) may be transferred to the BWB-B, and the UCAV could use the same control-station terminals. A BWB pioneered for the BWB-B would also likely make tanker and mobility variants attractive, allowing a single training pipeline to service two-thirds of the CAF and some significant portion of the MAF and making it easy to cross-flow aircrews between systems. Thus, the Air Force could have pilots with both manned ("air sense") and remotely piloted experience, creating substantial flexibility in rated management and better paths to leadership development. It would also enable an entirely different Guard/Reserve concept of operations. Consequently, the Air Force could rapidly shuttle missions to remote operators or retain a pool of avionics-qualified individuals as true reservists who need only complete a flight physical and altitude-chamber training to return to flying status.

Sixth, the advantages for our industrial base would be profound, permitting no fewer than five open assembly lines. In this proposed force structure, procuring the F-35 in lower numbers becomes attractive—principally to team with the UCAV. It also reopens the F-22 line, giving us no fewer than three concurrent fifth-generation tactical air lines. The UCAV and LRS-B purchases are large enough that we might consider encouraging licensed production by other contractors, as we did in World War II, to broaden the industrial base and allow faster procurement. The decision to pursue a BWB-B would significantly advance US commercial aviation. Inclusion of new platforms is a feature—not a mistake or unintended consequence—in the emerging political space as long as it remains rationally linked to strategy and jobs.

Finally, such a force provides an attractive option from a political perspective by making the Air Force appear both responsive and visionary. The story is simple, with simple numbers: a combat aircraft fleet of 66 squadrons and 2,000 aircraft, two-thirds of them capable of long-range strike and two-thirds capable of remotely piloted operation—something that any policy analyst or airpower advocate can ex-

plain quickly in simple terms. It gives the Air Force both competitiveness and a visionary role in the nation's industrial base. Moreover, it substitutes new projects and "spreads the wealth" across both defense contractors and congressional districts to the extent that it should allow scale-back of the F-35 overcommitment with the least pain.

Conclusion

According to this analysis, the force structure of the mid-2030s will not resemble what is presently in the program objective memorandum and program force-extended. The latter are deficient in long-range, survivable UCAVs but overcommitted to RPAs that can survive only in permissive environments and to short-range manned fighters that force the United States to operate inside threat rings. Careful examination would show that a convergence of forces will not let this stand.

If a range-balanced force represents the future, one way or another, the Air Force would do well to march resolutely toward a force structure that is clearly adaptive to current threats and easily articulated—one that offers a clear vision for the future of airpower. Such a structure will give policy makers the justification to secure required resources rather than attempt to maintain the current course, which would have to adapt at a future date. An early change to a range-balanced force would also let the service apply some degree of strategic planning to pursue all of the rationalizations and synergies that such a force could present. That path is preferable to arriving at something similar by cobbling together pieces without the benefit of thoughtful design and interoperability.

The rebalance toward the Asia-Pacific and the new defense strategy outline areas where we can establish priorities of investment. An Air Force proposal that seeks to adapt itself to this new reality while moving smartly forward by advancing remotely piloted aviation and providing a visionary, forward-looking strategy for the national dual-use air and space industrial base will probably be well received. This is es-

pecially true if it involves simple numbers and concepts that are easily communicated. A basic 66-squadron CAF of 2,000 aircraft composed of one-third bombers, one-third UCAVs, and one-third manned fighters fits that bill, and the convergent forces will probably take us there. If that is where the winds are blowing, let us not fight this jet stream of convergent forces but place ourselves in its tailwind, pick the range-balanced force as the guiding star, and move confidently toward the future. ✪

Notes

1. Opposing factors include resistance from the fighter community, the need to export fighters in the global market, the need for flexibility to adapt to black swans (unexpected, largely unpredicted events such as the terrorist attacks of 11 September 2001), the need for mass versus performance versus defense budgets, the risk of relying on networks in a contested cyber environment, and ethical considerations.

2. Department of Defense, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* (Washington, DC: Department of Defense, January 2012), 4–5, 2, http://www.defense.gov/news/defense_strategic_guidance.pdf.

3. "The Force behind THE FORCE," Air Force Association, slide 2, accessed 17 April 2013, http://www.afa.org/professionaldevelopment/issuebriefs/F-22_v_F-35_Comparison.pdf; Philip Ewing, "The Air Force's Simple, No-Frills, Advanced New Bomber," Military.com, 13 February 2012, http://www.dodbuzz.com/2012/02/13/the-air-forces-simple-no-frills-advanced-new-bomber/; and Dave Majumdar, "USAF's LRS-B Bomber Proceeds, but Is Completely Classified," Flightglobal, 21 August 2012, http://www.flightglobal.com/blogs/the-dewline/2012/08/usafs-lrs-b-bomber-proceeds-bu.html..

4. *Top line* is a business term for gross revenues, used in the Pentagon to denote the total budget given to a service or the total obligation authority.

5. Department of Defense Directive (DODD) 3000.09, *Autonomy in Weapons Systems*, 21 November 2012, 13, http://www.dtic.mil/whs/directives/corres/pdf/300009p.pdf.

6. This reflects my impressions after spending two years of intense engagement with think tanks, policy makers, and the press in the National Capital Region.

7. Human Rights Watch, *Losing Humanity: The Case against Killer Robots* (Washington, DC: Human Rights Watch, 2012), http://www.hrw.org/sites/default/files/reports/arms1112ForUpload_0_0.pdf.

8. Dr. Peter Singer, to the author, e-mail, 10 December 2012.

9. Government Accountability Office, *Nonproliferation: Agencies Could Improve Information Sharing and End-Use Monitoring on Unmanned Aerial Vehicle Exports* (Washington, DC: Government Accountability Office, July 2012), see "What GAO Found" (page following title page), http://www.gao.gov/assets/600/593131.pdf.

10. Secretary of Defense Robert M. Gates (remarks to Air War College, Maxwell-Gunter AFB, AL, 21 April 2008), http://www.defense.gov/speeches/speech.aspx?speechid=1231.

11. President Barack H. Obama, Secretary of Defense Leon E. Panetta, and Chairman of the Joint Chiefs of Staff Gen Martin E. Dempsey, "Defense Strategic Guidance from the Pentagon," news transcript (Washington, DC: Department of Defense, Office of the Assistant Secretary of Defense [Public Affairs], 5 January 2012), http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4953.

12. DODD 3000.09, *Autonomy in Weapons Systems*.

13. AF/A8XC, to the author, e-mail, 10 December 2012; and Dan Parsons, "Air Force F-35s, Drones May Square Off in Budget Battle," *National Defense* 96, no. 699 (February 2012): 28–29, http://digital.nationaldefensemagazine.org/i/53735/29.

14. Department of Defense, *Sustaining U.S. Global Leadership*, 8.

15. "The Aerospace Industry in the United States," SelectUSA, accessed 28 February 2013, http://selectusa.commerce.gov/industry-snapshots/aerospace-industry-united-states.

16. "F-35 Lightning II Joint Strike Fighter (JSF), United States of America," airforce-technology.com, accessed 28 February 2013, http://www.airforce-technology.com/projects/jsf/; and Bruce Rolfsen, "Despite Problems, AF Plans to Stick with F-35," *Air Force Times*, 26 April 2010, http://www.airforcetimes.com/news/2010/04/airforce_f35s_041310w/.

17. A question arose about completely eliminating short-range, manned fighters, given their operational limitations, the most significant of which is limited range for the contingencies imagined. These aircraft maintain balance and allow operational flexibility in several ways. First, unlike remotely piloted systems, they do not face operational restrictions in national airspace, where laws or regulations require a pilot. Second, short-range assets can posture forward without extending a threat ring over unintended third parties. Third, manned aircraft signal a certain resolve and provide a trip wire. Finally, they offer resilience in case remotely piloted systems cannot keep up with the complexity of the operational environment or experience a compromise of either command and control or autonomy. A second question arose regarding cancelling the F-35 entirely and buying all F-22s or purchasing greater numbers of 4.5-generation fighters such as the Silent Eagle of F-16 block 60 rather than relying on significantly lower numbers of aircraft, depending on their stealth for survivability.

18. The following assumes that we could begin procuring our force in 2020 and wish to finish by 2035: 2,000 total aircraft / 15 years = a commitment to buy 133.3 aircraft per year from the 2008 high of 180 and current low of 59 (24 of which are MQ-9s): $6,216 million = 44.4 manned fighters each at $140 million (average of F-22 $143 million and F-35 $135 million) + $3,552 million = 44.4 UCAVs each at $80 million + $22,200 million = 44.4 bombers each at $500 million = $31,968 million = average annual acquisition costs for the CAF, 2020–35 versus $50,000 million = 100 bombers x $500 million + $238,005 million = 1,763 F-35s x $135 million = $288,005 million (not accounting for other CAF acquisitions and service-life extensions).

19. Industrial Analysis Center, Defense Contract Management Agency, presentation, subject: The Industrial Base, Aircraft Sector Industry Assessment, February 2012.

20. Department of Defense, *Sustaining U.S. Global Leadership*, 4.

21. AF/A9 is the Analysis Division of the Air Staff; OSD/CAPE is Cost Assessments and Program Evaluation under the Office of the Secretary of Defense.

22. Ashley J. Tellis, *Dogfight: India's Medium Multi-Role Combat Aircraft Decision* (Washington, DC: Carnegie Endowment for International Peace, 2011), 15–16, http://carnegieendowment.org/files/dogfight.pdf.

23. International Institute of Strategic Studies, *The Military Balance 2013* (London: International Institute of Strategic Studies, 2013). The numbers are summarized in *Wikipedia: The Free Encyclopedia*, s.v. "Russian Air Force," http://en.wikipedia.org/wiki/Russian_Air_Force.

24. The cost of an aircraft is roughly its weight in thousands of pounds x $0.65 million + $25 million. That calculation underestimates the known cost of the F-22 and F-35, but the comparison is still proportional. Legacy force structure is assumed to be 187 F-22s at 43.4 thousand pounds [43.4 x $.65 = $28.21 + $25 = $53.21/plane x 187 = $9,950]; 1,763 F-35s at 29.3 thousand pounds [29.3 x $.65 = $19.045 + $25 = $44.045/plane x 1,763 = $77,651]; and 100 LRS-Bs at 100 thousand pounds [100 x $.65 = $65 + $25 = $90/plane x 100 = $9000], a total of [$9,950 + $77,651 + $9000 = $96,601] $96,601 million. The proposed force is as reported above, with the BWB-B assumed to be 100,000 pounds empty weight, totaling $111,954 million with a ratio between the two of 115 percent.

25. Custom briefing requested by SAF/FMCC (Directorate of Cost Analysis), slide 16: "Cost per Flying Hours Discussion," 27 April 2011.

26. A significant objection is that the smaller buy of F-35s would push up the unit cost, eroding some of the savings for the UCAV.

27. Department of Defense, *Sustaining U.S. Global Leadership*, 6.

28. "Loyal wingman technology differs from swarming in that a UAS [unmanned aircraft system] will accompany and work with a manned aircraft in the AOR [area of responsibility] to conduct ISR, air interdiction, attacks against adversary integrated air defense systems (IADS), offensive counter air (OCA) missions, command and control of micro-UAS, and act as a weapons 'mule,' increasing the airborne weapons available to the shooter. This system is capable of self-defense, and is thus, a survivable platform even in medium to high threat environments. The loyal wingman UAS could also be a 'large' UAS that acts as a cargo train or refueling asset." Headquarters US Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan, 2009–2047* (Washington, DC: Headquarters US Air Force, 18 May 2009), 34, http://www.fas.org/irp/program/collect/uas_2009.pdf.

29. Guy Norris, "Future-Airliner Concept Contenders Reveal Design Surprises," *Aviation Week*, 16 January 2012, http://www.aviationweek.com/Article.aspx?id=/article-xml/AW_01_16_2012_p21-413463.xml#.

30. Critical new engine technology includes higher-temperature and adaptive-flow technology such as that being pioneered in the Air Force Research Laboratory's ADVENT and HEETE programs.

31. Headquarters US Air Force, *Unmanned Aircraft Systems Flight Plan*.

32. Ibid., 39.

33. Ibid., 40.

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