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Building Agile Combat Support Competencies to Enable Evolving Adaptive Basing Concepts

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Preface

For several years, the U.S. Air Force has been grappling with how to survive and fight in contested, degraded, and operationally limited (CDO) environments, and one of its recent innovations has been the advancement of basing concepts that require significant resilience and mobility of combat forces. Headquarters Air Force (HAF) has sought to bring some of these survivability-focused concepts under one umbrella, which was originally called *adaptive basing*.¹ As the operational community pursues these concepts, it raises difficult questions as to how the Agile Combat Support (ACS) community would support such concepts.

Adaptive basing is not yet the official policy of the Air Force, and it is not the only concept under development for operating in CDO environments. Therefore, the Air Force does not have a clearly defined set of operational requirements from which to develop ACS requirements for capabilities, resources, and training. Nonetheless, the ACS community seeks to understand what it might be called on to provide the operational forces to enable the kind of adaptiveness and agility currently being contemplated.

In this report, we review the motivations for adaptive basing, estimate its requirements for ACS, consider the obstacles to fulfilling those requirements, and discuss the implications and recommendations for the ACS community and the Air Force as a whole. We define adaptive basing and provide a framework for thinking about how it operates. In this report, we take a building-block approach, distilling operational concepts and translating them into what they require of ACS forces. We also provide a view of the potential obstacles to executing adaptive basing concepts and discuss the need for additional analyses to flesh out the pursuit and value determination of such concepts. Our recommendations address (1) how to modify ACS to pursue adaptive basing and (2) how to assess its value. This report supersedes an earlier report that was written as part of this research project, titled *Building ACS Competencies to Enable Evolving Adaptive Basing Concepts* (Mills et al., 2019, Not available to the general public).

The research reported here was commissioned by the U.S. Air Force and conducted within the Resource Management Program of RAND Project AIR FORCE as part of a fiscal year 2017 project titled “Agile Combat Support (ACS) for Adaptive Basing.” The work was sponsored by the Deputy Chief of Staff for Logistics, Engineering and Force Protection (A4), and should be of interest to operations and Air Force combatant commanders, planners, and logisticians.

¹ At the time this research was conducted, HAF’s concept was called adaptive basing. At the time this report was being published in its final form, however, the Air Force was seeking to unify and standardize its terminology and it generally converged on *agile combat employment*. In this report, we use *adaptive basing* to encompass the variety of operating and basing concepts that require adaptiveness, responsiveness, and agility to survive and operate in CDO environments.

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Summary

To persevere in contested, degraded, and operationally limited (CDO) environments, the U.S. Air Force and regional warfighting commanders are exploring alternative force deployment and employment concepts under an umbrella initiative called *adaptive basing* (AB).² The prospect of operating in CDO environments has prompted Air Force leaders to consider several of the AB concepts for improving installation and force resilience, enabling combat force maneuver operations, and sustaining operations under fire. Fundamentally, AB is about the ability to avoid or survive attacks and continue operating in theater despite those attacks.

The Air Force is several years into a process of exploring and experimenting with AB and analogous concepts. Should the Air Force pursue AB, there will be a long road toward fleshing it out and implementing it. A key challenge today is for the Air Force's operators, planners, and logisticians to engage in an informed conversation about what AB operational capabilities would be required, what Agile Combat Support (ACS) logistical forces could do to fulfill the AB requirements, and how these communities might need to adjust their expectations or perspectives to bridge the gaps.

In the past few years, the Air Force has encouraged the operational and logistics communities to deepen this conversation. The discussions of ACS requirements for AB that appear throughout this report are intended to contribute to this ongoing dialogue.

Adaptive Basing and Its Implications for Agile Combat Support

AB is the Air Force's attempt to rationalize and unify a variety of concepts—some complementary, some competing—under a single umbrella and into an AB warfighting toolkit. One thing that makes it challenging to define AB is that only a subset of the activities under the all-inclusive AB umbrella could reasonably be described as adaptive, while numerous routine or traditional activities are envisioned as operating in tandem with the adaptive ones.

Upon surveying the variety of concepts that the Air Force has categorized as part of AB, we found that all of them—adaptive or not—can be characterized as survival strategies. Their intent

² AB is not yet Air Force policy; it also is not the only concept for warfighting in CDO environments. Over the past several years, Headquarters Pacific Air Forces has developed the Agile Combat Employment (ACE) concept to address its own regional operational challenges. Similarly, Headquarters United States Air Forces Europe is considering several concepts of operations that draw on AB concepts. In August 2019, the Air Force held a symposium of warfighting and supporting commands with the intent to rationalize and institutionalize the various concepts. At the time this report was being published in its final form, the Air Force was generally converging on using *ACE* as an enterprisewide blanket term. In this report, we use *adaptive basing* to encompass the variety of operating and basing concepts that require adaptiveness, responsiveness, and agility to survive and operate in CDO environments.

is to extend survivability, even if they are not inherently adaptive. Thus, AB is less about increasing the adaptiveness of aircraft and air forces than it is about extending their survivability through strategies that are both traditional *and* adaptive. For this reason, we offer a new working definition of AB, even if this definition broadens the scope of the Air Force's current understanding of AB: *Adaptive basing* is the U.S. Air Force's effort to extend the survivability of combat forces and the operational resilience of those forces in CDO environments through combinations of traditional and adaptive strategies that could vary from site to site and campaign to campaign.

In this report, we focus on the adaptive, or alternative, force deployment and employment concepts for AB. From a collection of today's leading AB concepts, we identify three ACS competencies and operational priorities that would be critical to implementing many of the AB concepts: (1) *integrated basing* (using networks of bases); (2) *flexible operations* (for Combat Air Forces, offering maneuverable multiplatform mission-generation maintenance not tied to a specific flying unit); and (3) *rapid scalability* (scaling the integrated bases up and down to support maneuverable forces).³ The first priority would serve as a launchpad for the second and third priorities.

Simply put, the core AB concepts require ACS to operate integrated-basing designs, conduct flexible operations, and rapidly scale base capabilities. The ACS community has the capability to build and manage bases and generate and sustain sorties, but AB concepts demand that the ACS community execute these capabilities in a different way that is built on new competencies. This trio of operational concepts encapsulates the essence of the competencies required to execute AB.

Integrated-basing concepts range from cluster basing to hub-and-spoke operations to shell games. The key idea is that operational resilience across a network of integrated bases would emanate from the *group* of bases, not just from highly protected single bases. Each network would incur costs, particularly in terms of the periodic movement of ACS equipment and personnel.

Flexible operations would entail regular movements of aircraft among the integrated bases, which could be serviced for sortie regeneration by multiplatform sortie-generation flightline maintenance units not necessarily associated with the operational flying units. This would offer increased operational flexibility and support force maneuver. Maintenance and weapons crews would need to be dispersed across a higher number of potential operating sites, and combat aircraft would need to be routinely serviced by personnel from different units.

Rapid scalability would involve the responsive scaling up or scaling down of operations at one or more bases in theater. This is not something that the Air Force has done during a contingency. Rather, the Air Force traditionally has planned deliberate, predictable buildups of

³ Much of the focus of AB and analogous concepts is on increasing the survivability of the Combat Air Force, which is the target of one of our three competencies for reasons that will become clearer later in this report.

forces. For the Air Force to conduct operations in a scalable way, the ACS community would need to be able to rapidly expand and contract the capabilities of integrated bases.

One can think of these three competencies as ACS building blocks that could support a variety of agile, survivable operating concepts. Without knowing exactly which operational concepts will be called for and when, the ACS community nonetheless can assess what these building blocks imply for its own force development.

The Challenges of Adaptive Basing

The Air Force faces two broad challenges in developing alternative AB concepts. The first is operational: understanding how the AB concepts would function in operational environments and what the benefits, limitations, risks, and costs would be. The second is institutional: determining where to invest in organizing, equipping, and training the force such that combatant commanders would have choices of AB concepts to use when confronting adversaries in CDO environments. For example, one combatant commander might need investments in traditional base protection, while another might need investments in alternative concepts, such as operational maneuver. Each AB concept could necessitate different capabilities, different investments, and different ACS tools.

Air Force leaders need to decide which operational and institutional changes would help the force respond best to a variety of combatant commander requests. The ACS implications of the alternative AB concepts would extend far beyond the traditional ACS tasks of prepositioning assets, securing host-nation agreements for support, and investing in infrastructure at permanent operating locations. As the Air Force did in the 1990s, when it redefined itself as an Expeditionary Aerospace Force, the Air Force once again needs to address fundamental questions about how it should structure its deployment packages, what level of support it should provide the forward-deployed forces, and what risks it should accept so that those deployed forces can survive and continue operating in the face of enemy attacks.

Importantly, AB largely substitutes one type of risk for another. In the interest of mitigating the risk of being targeted by enemy missiles, commanders will be asked to accept the following types of risks: insufficient sortie-generation capacity and sustainability, insufficient capability to prevent or recover from ground attacks or accidents, and human performance degradation. The relative favorability of these trade-offs is not yet well understood. Fully accounting for these risks is beyond the scope of this report, but it is a topic that deserves serious attention. As planners and commanders better understand how the various tools in the AB toolkit function, they also must come to understand the incumbent risks to make informed trade-offs.

The Three Types of Agile Combat Support Competencies and Key Obstacles

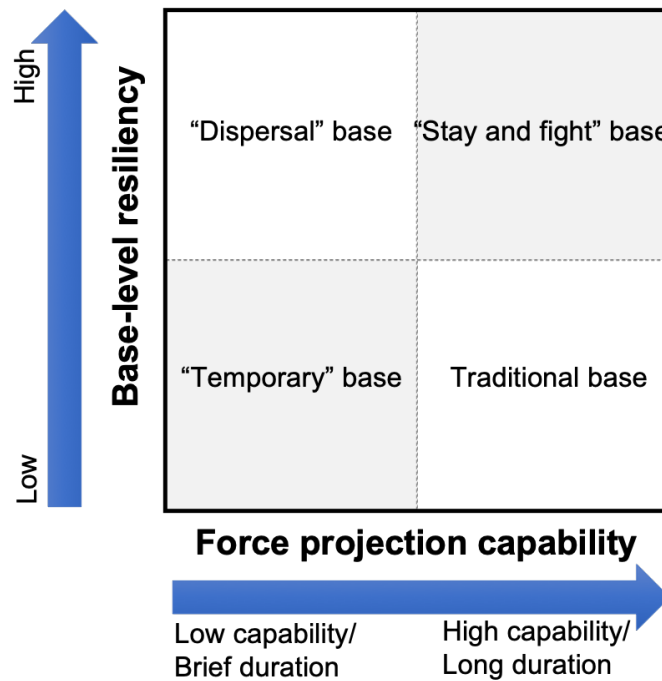
To estimate the resources required to support integrated basing, flexible operations, and rapid scalability, we built a model to calculate the footprint requirements implied by these concepts. The footprint model applies to all three concepts; it estimates the footprint that would need to be put in place to make each concept operational. Although the footprint model estimates the total *amount* of capabilities or resources required, a separate analysis was necessary to assess the *time* required to relocate those capabilities.⁴

Agile Combat Support Competencies for Integrated Basing

The concept of integrated basing allows great leeway for tailoring bases to suit operational objectives, threat environments, and logistical constraints. However, this puts the Air Force in a tough spot: It needs to match the tailored bases to the logistical support requirements for a profusion of base types. To help overcome this difficulty and facilitate the conversation between planners and logisticians, we present a framework for consolidating all possible types of integrated bases into four base archetypes. As depicted in Figure S.1, this framework for base archetypes compares the bases along two dimensions: base-level resilience and force-projection capability.

⁴ We built a separate model to analyze transportation time, which will be described in forthcoming research by Anna Jean Wirth and Jonathan Welburn.

Figure S.1. Framework for Characterizing Adaptive-Basing Archetypes



A *traditional base* is a robust base outside the enemy’s threat range that is capable of prolonged operations but typically is not equipped with high investments in resilience. A *stay-and-fight base* is capable of prolonged operations and is equipped with resilience resources. A *dispersal base* is resilient but is designed for only brief operations by aircraft fleeing an enemy attack. A *temporary-use base* has minimal resilience investments and minimal force-projection capability; in fact, it is viewed as an acceptable loss if attacked on completion of its short-term operations.

We determine that the obstacles to fulfilling the ACS requirements for integrated basing are

- limited resources, particularly for the dispersal of bases (which could require more resources per aircraft than required by traditional bases) and for resilience measures
- personnel limitations, because operational and logistics planners are not trained to design *networks* of bases for operational adaptiveness throughout the course of a contingency; furthermore, deploying personnel are not trained to operate from a network of bases
- incomplete analyses, because the operational benefits, along with the full costs and resource requirements, of many different designs of integrated-basing networks have not yet been assessed.

Agile Combat Support Competencies for Flexible Operations

Flightline maintenance to support flexible operations can be scaled to two different levels. The first would be the capability to recover aircraft, refuel them, and send them on their way. This capability is commonly practiced in the Air Force as transient alert (TA) servicing. The

second would be the capability to recover aircraft after a sortie, refuel them, reload their munitions, and launch another sortie. We call this capability *launch and recover* (L&R). The key difference between the two categories of flexible operations is that L&R would include weapons loading and TA would simply involve refueling. For both concepts, the intent is to be at the recovery location for 24 hours or less and use maintenance repair teams in the event that an aircraft experiences a fault or failure that threatens airworthiness.

We found four key obstacles to implementing flexible operations in general and to fulfilling the ACS requirements for these operations in particular:

- Combat Air Forces have a culture that values unit integrity among aircrews and maintenance crews
- current tactics, techniques, and procedures extend time on the ground and exposure to attack
- the need to train ACS maintenance personnel to service multiple types of combat aircraft
- the Unit Type Code (UTC) deployment structure, which is premised on the idea that ACS personnel will deploy to a single forward operating location and operate only from there rather than fulfill the ACS requirements for flexible operations from multiple locations.

Agile Combat Support Competencies for Rapid Scalability

We estimated the airlift (or footprint) requirements and the resulting transportation times for rapid scalability and linked the estimates to the base archetypes. AB concepts suggest that the capability of a base might need to be scaled up or down as the threat of enemy attack changes over the course of a conflict. We see the following obstacles to fulfilling the ACS requirements for rapid scalability:

- the need to redesign bases around the most-critical activities and support functions
- the need to redesign force packages for incremental buildups
- the need for sufficient personnel trained in mobility-focused skills, such as load planning, joint inspection, and forklift operations (depending on the scale by which rapid scalability must be executed, existing aerial port and contingency response units might not be sufficient)
- the need for a network of prepositioned equipment locations configured to responsively provide the right mix of equipment and rapidly deploy it
- the need to redesign the defense transportation system for rapid, responsive movement
- the need to balance resources between operational and deployment readiness.

Implications and Recommendations

We highlight three implications for the ACS community and three for the broader Air Force. The implications for the ACS community lead to two recommendations, while the implications for the broader Air Force lead to one recommendation.

Implications for the Agile Combat Support Community

- **The design of current force packages is ill-suited for executing AB concepts.** Most force packages are not designed for incrementally scaling capabilities up or down.
- **Implementing AB concepts would require the ACS community to develop new competencies for employing ACS capabilities.** The new ACS competencies include those for operating integrated-basing networks, providing flightline maintenance at the integrated bases to support flexible operations, and scaling base capabilities rapidly.
- **Although changes to ACS organization, training, and deployment practices could enable the ACS community to implement AB concepts more efficiently, much work remains to be done to assess the investment, risk, and performance implications.**

Implications for the Air Force

- **AB represents a fundamental pivot in how the Air Force presents forces to warfighting commands.** Because AB would introduce wide-ranging changes in how the Air Force prepares and delivers forces to the warfighting commands, the changes would take time to implement.
- **Coalescing around a common view of the intended outcomes of AB could accelerate the implementation process.** Concurrence among planners and logisticians on the beneficial outcomes that AB concepts could offer combatant commanders would help all parties recognize which concepts should be pursued under which circumstances and, thus, which ACS activities would be most helpful.
- **The dynamics of AB would require a renewed focus on mastering the operational art of war.** The operational art of war would encompass contingency planning and execution, tactical command and control for ACS, and the tailoring of AB force deployment and employment concepts for each new contingency. These skills have atrophied over the years as a result of regular, rotational force deployments.

Recommendations for the Agile Combat Support Community

In keeping with the three implications for the ACS community, we offer the community recommendations in two corresponding areas: mission and base force package redesign and personnel skill design.

Mission and Base Force Package Redesign

The ACS community should consider overhauling the force packages used for deploying and presenting forces to combatant commanders. The current design of UTCs would not permit the type of modular capabilities and incremental force buildups required by the AB concepts. We therefore suggest the following four-step approach for taking on the redesign challenge:

1. **Decompose the AB mission demands into their component parts.** Specify what the AB concepts demand in terms of mission capacity and duration, human performance and endurance, defense against attacks, and recovery from attacks.

2. **Reconfigure the force package building blocks.** UTCs should still be the building blocks of force projection, but new UTCs, built to serve the incremental AB mission demands, would better enable AB execution. The configuration of UTC packages also would need to become more diverse to match the variety of alternative AB concepts being developed.
3. **Train force package designers.** Recognition of the UTC package design function as a critical and valued skill could promote the ongoing, dynamic development of new UTCs for the evolving AB concepts intended for use in diverse CDO environments.
4. **Develop a library of new force module designs.** Force modules are predefined subsets of UTC packages. The ACS community could develop a library of UTC force modules to enable rapid planning and replanning for integrated, flexible, and scalable AB operations.

Personnel Skill Design

The ACS community should consider personnel skill design and personnel development activities that could help fulfill the ACS requirements for AB. There are two broad categories of personnel skill design that are worth noting. First is what might be called *basic airmanship*, i.e., the skills most airmen should have to capably deploy into an expeditionary environment. It could be argued that to operate in CDO environments or stand-in bases, airmen require a broader complement of skill sets, but all airmen might require more than the status quo. Three such skills are most common in AB-related discussions: medical care (e.g., self-aid buddy care), protection or defense (e.g., more-advanced training on basic weapons), and deployment agility (e.g., Phase 1 and Phase 2 exercises).

Beyond basic skills that a broader variety of airmen ought to have, some AB concepts lead to a discussion about having personnel trained and certified in areas outside their primary functions (sometimes referred to as *cross-utilization training*).⁵ This could reduce the footprint of a deployed force, increase its deployment speed and agility, alleviate constraints associated with operating from many small bases, and increase the resilience of the force when it suffers casualties. However, not all cross-training would accomplish the same objectives. Many cross-training opportunities exist, and some Air Force research already has been devoted to this. Two areas in particular are mission generation (e.g., cross-servicing of aircraft types) and more-advanced deployment skills (e.g., load planning, joint inspection, and forklift operation). There is ongoing experimentation with cross-training in both areas.

In both cases, an analytic framework is needed to determine which skills are most critical for AB and which could be successfully added or combined and sustained within one or more career fields. Many skills could be incorporated, but careful analysis should reveal the best path forward.

⁵ The Air Force is now using the term *Multi-Capable Airman* to refer to a range of cross- or multitasking.

Recommendation for the Air Force: Experimentation Campaign

The Air Force should consider an experimentation campaign to test various aspects of implementing AB concepts. This recommendation likely will be more time- and resource-intensive and could take longer to realize than the first two. The goals of this campaign would be threefold, in keeping with the three implications of AB for the Air Force expressed earlier:

1. expedite the pivot toward AB
2. cultivate a common view of the intended outcomes of AB
3. revive the operational art of war.

Experimentation campaigns customarily are designed to take an incremental approach to developing and practicing the various elements of new concepts. Such campaigns are structured to accomplish short-term and long-term objectives through a variety of methods, such as workshops, brainstorming events, tabletop exercises, wargames, simulations, and field experiments. One benefit of such campaigns is that some activities could be accomplished in parallel, which would accelerate implementation.

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That we received help and insights from those acknowledged above should not imply that they concur with the views expressed in this report. Responsibility for the content of this report, and its analyses and conclusions, lies solely with the authors.

Abbreviations

AB	adaptive basing
ACC	Air Combat Command
ACE	Agile Combat Employment
ACS	Agile Combat Support
ADR	Airfield Damage Repair
ADVON	advanced echelon
AEF	Air Expeditionary Force
AF/A4	Logistics, Engineering, and Force Protection Directorate
AMC	Air Mobility Command
ATO	air tasking order
BOS	base operating support
C2	command and control
CAF	Combat Air Force
CDO	contested, degraded, and operationally limited
CONUS	continental United States
CRG	Contingency Response Group
DoD	U.S. Department of Defense
EAF	Expeditionary Aerospace Force
EMEDS	Expeditionary Medical Deployment System
EOD	explosive ordnance disposal
EST	Enroute Support Team
FARP	forward arming and refueling point
HQ	headquarters
I&W	indications and warning
ICT	integrated combat turn
IOC	initial operating capability

L&R	launch and recover
Lean-START	Lean Strategic Tool for the Analysis of Required Transportation
MAF	Mobility Air Force
MDS	mission-design series
MISCAP	mission capability
MOB	main operating base
MOG	maximum on ground
MRT	maintenance repair team
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PAA	primary assigned aircraft
PACAF	Pacific Air Forces
QOL	quality of life
QRF	quick reaction force
RADR	rapid airfield damage repair
SME	subject-matter expert
STON	short ton
TA	transient alert
TTP	tactics, techniques, and procedures
USAFE	United States Air Forces Europe
UTC	Unit Type Code
WMP	War and Mobilization Plan
WRM	war reserve materiel

1. Introduction: The Challenges of Adaptive Basing

A Survival Strategy

In many potential operating environments today, the U.S. Air Force faces adversaries that are increasingly capable of limiting where and how the Air Force projects combat power. Whether the environments are called *anti-access/area denial* (A2/AD) environments or *contested, degraded, and operationally limited* (CDO) environments, their common salient feature is that of adversaries with larger numbers of more-precise missiles with more reach than before, thus threatening traditional U.S. air bases like never before.⁶

To persevere in these environments, which we call *CDO environments*, the Air Force, regional warfighting commanders (the combatant commanders), and their staffs are exploring numerous combinations of traditional and alternative force deployment and employment concepts. To lend cohesion to these rapidly evolving, often overlapping, and sometimes mutually exclusive concepts that have been brewing across the different combatant commands, the Air Force has placed all of the concepts under an umbrella initiative called *adaptive basing* (AB).⁷

In essence, AB is about the ability to avoid or survive attacks and to continue operating in theater despite them. Because the threats differ by theater, the combatant commands and their Air Force components are weighing different concepts for different environments. The AB concepts point toward improving various aspects of installation and force resilience, dynamic command and control (C2), maneuver, and sustainment. However, each concept would entail resource and capability requirements and would pose *other* obstacles for the Air Force. This report focuses on the requirements, obstacles, implications, and recommendations for the Air Force's Combat Support enterprise. By definition, *Combat Support* is "the foundational and

⁶ As is often the case with popular and controversial topics in the defense community, competing lexicons abound. For several years, A2/AD has been virtually ubiquitous. But recently, the Chief of Naval Operations declared that the U.S. Navy would abandon the term (Christopher P. Cavas, "CNO Bans 'A2AD' as Jargon," *Defense News*, October 3, 2016). The competing terms—*contested, degraded, limited, denied*, etc.—all attempt to capture the challenging, evolving, and sometimes murky nature of the threats. We will use *CDO* throughout this report to refer to a collection of terms that describe the security environment as limiting the Air Force's force-projection capability.

⁷ AB is not yet Air Force policy, and it is not the only concept for warfighting in CDO environments. Over the past several years, Headquarters (HQ) Pacific Air Forces (PACAF) has developed the Agile Combat Employment (ACE) concept to address its own regional operational challenges. Similarly, HQ United States Air Forces Europe (USAFE) is considering several concepts of operations that draw on AB concepts. In August 2019, the Air Force held a symposium of warfighting and supporting commands with the intent to rationalize and institutionalize the various concepts. At the time this report was being published, the Air Force was generally converging on using *ACE* as an enterprisewide blanket term. In this report, we use *adaptive basing* to encompass the variety of operating and basing concepts that require adaptiveness, responsiveness, and agility to survive and operate in CDO environments.

crosscutting capability to field, base, protect, support, and sustain Air Force forces during military operations across the competition continuum.”⁸

What Is Adaptive Basing?

AB is the Air Force’s attempt to rationalize and unify a variety of concepts—some complementary, some competing—under one umbrella and into an AB warfighting toolkit.⁹ One challenge to defining AB is that only a subset of the activities included under the AB umbrella could reasonably be described as adaptive, while numerous other activities are more traditional and envisioned as operating in tandem with the adaptive ones.

Therefore, it can be argued that the word *adaptive* itself is too restrictive for AB purposes. *Adaptive* means the ability to adjust to different conditions or environments, but some AB strategies are not so adjustable. Upon surveying the variety of concepts that the Air Force has placed under the AB umbrella, we found that all of them, whether adaptive or not, can be characterized as survival strategies—i.e., their intent is to extend survivability, even if they are not inherently adaptive. In fact, AB is less about increasing the adaptiveness of aircraft and air forces than it is about extending their survivability through strategies that are both traditional *and* adaptive.

We offer a working definition of AB that accounts for both types of strategies, even if this definition broadens the scope of the Air Force’s current understanding of AB: *Adaptive basing* is the U.S. Air Force’s effort to extend the survivability of combat forces and the operational resilience of those forces in CDO environments through combinations of traditional and adaptive strategies that could vary from site to site and campaign to campaign.

In addition to encompassing traditional and adaptive strategies, AB encompasses two aspects of exercising command. The first is the AB toolkit. If and when it is used, the AB toolkit would be a catalog of operational concepts, offering combatant commanders a selection of warfighting instruments not seen before. The second is a renewed emphasis on the operational art of war—i.e., on “the use of creative thinking by commanders and staffs to design strategies, campaigns, and major operations and [to] organize and employ military forces.”¹⁰ In other words, AB would rely on both new sets of warfighting tools and new and creative ways of using such tools.

⁸ U.S. Air Force Doctrine Annex 4-0, *Combat Support*, Washington, D.C., January 5, 2020, p. 2.

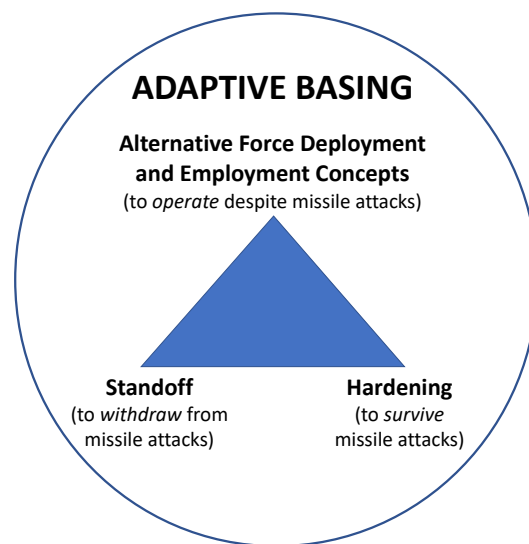
⁹ The Air Force has not released an official document on, or definition of, AB. Therefore, we attempt to synthesize many discussions with planners and logisticians, briefings on AB, reports from exercises and wargames, and information from other sources to distill the essence and salience of AB for the Agile Combat Support (ACS) community.

¹⁰ U.S. Department of Defense, Joint Publication 3-0, *Joint Operations*, Washington, D.C., incorporating change 1, October 22, 2018.

The Adaptive Basing Umbrella

Figure 1.1 illustrates the all-encompassing AB sphere, which involves static concepts and adaptive concepts. The base of the triangle represents the concepts on which most of the work in the Air Force has focused to date: traditional standoff and hardening concepts. *Standoff* refers to rearward-basing strategies to *withdraw* forces from exposure to missile attacks. *Hardening* refers to forward-based protection and recovery strategies to *survive* missile attacks. The top of the triangle represents more-dynamic force deployment and employment concepts to help forward-based forces operate despite missile attacks. Research into this third, alternative area of AB has been pursued in earnest only within the past five years.

Figure 1.1. Adaptive Basing Encompasses a Variety of Concepts



When Air Force personnel speak of AB, they often refer to the top of the triangle only—the adaptive point of the triangle. However, AB needs all three points of the triangle to hold together. The baseline strategies of standoff and hardening are necessary, but not sufficient: The full portfolio is required. Standoff, hardening, and the adaptive AB concepts represent three types of mechanisms for confronting the challenges of CDO environments. All three will need to be coordinated by commanders. Creatively choosing from among the three and combining them as necessary to fight and win in CDO environments, depending on the operational circumstances, is what will constitute the operational art of war.

Evolving Operational Concepts

Before AB became a term of art, numerous competing adaptive or dynamic operational concepts emerged. We take inventory of the following eight recent concepts to provide background for the operational vignette in the next section:

1. Flex-basing: PACAF developed this concept, under which threatened forces, given indications and warning (I&W), would temporarily escape, or flex, to alternate locations to wait out an attack or fight from those alternate locations.¹¹
2. Dynamic basing: U.S. Pacific Command (PACOM) developed this concept, which aims to keep combat power survivable by keeping the logistics “tail” as close as possible to the combat “teeth.” Simply stated, dynamic basing depends on dynamic logistics.¹²
3. Cluster basing: This RAND Corporation–developed concept calls for several resilient bases of equal capability to be located close to one another to share resources and provide mutual support to one another in the event of attack. The Air Force’s draft AB Concept of Operations uses the term more broadly—i.e., “a basing approach that groups bases and operating locations geographically for mission continuity, ease of C2, supportability, and mutual protection.”
4. Rapid Raptor: This PACAF concept calls for the quick deployment of a package of F-22 Raptors and supporting logistics to any forward operating base in the world and for having the aircraft in combat-ready status within 24 hours of employment. The package would use one C-17 aircraft for carrying materials, munitions, and maintainers and later for moving, refueling, and rearming a minimum of four F-22s in unfamiliar, austere environments, leaving a small footprint.¹³
5. Rapid-X: This concept is very similar to rapid Raptor, but it was developed by HQ USAFE. Rapid-X calls for the quick deployment of any type of fighter aircraft (not just F-22s) to assist missions from bases that lack the full infrastructures that usually support fighter units in a major contingency. The concept calls for bringing in four fighter aircraft, rearming and maintaining them, having them fly another mission, and possibly vacating the assisted base. The intent is to use a wide variety of locations in Europe to challenge a potential adversary seeking to target aircraft and disrupt allied operations.¹⁴
6. Untethered operations: This concept is closely related to Rapid-X and also originated from USAFE. It seeks to leverage robust basing and North Atlantic Treaty Organization (NATO) partner interoperability to complicate Russian targeting and create an arsenal of options for allied combat operations in Europe. Under this concept, a small package of fighters could drop into a base with the support of only the personnel and equipment that could fit on a single C-17, conduct operations for several hours without bedding down overnight, and depart with the C-17, leaving the base essentially as it was found.¹⁵

¹¹ This concept is not to be confused with a previous RAND report that used the term *flexbasing* for a strategy of providing a high degree of operational and logistical flexibility by developing and maintaining a robust capability to deploy to, and operate from, a variety of locations with widely varying characteristics. See Paul Killingsworth, Lionel A. Galway, Eiichi Kamiya, Brian Nichiporuk, Robert S. Tripp, and James C. Wendt, *Flexbasing: Achieving Global Presence for Expeditionary Aerospace Forces*, Santa Monica, Calif.: RAND Corporation, MR-1113-AF, 2000.

¹² Harry B. Harris, Jr., speech delivered at the Logistics Officer Association Symposium, National Harbor, Md., October 13, 2016.

¹³ Marc V. Schanz, “Rapid Raptor Package,” *Air Force Magazine*, September 26, 2013.

¹⁴ Jon Harper, “U.S. Air Force Preparing for ‘High Volume’ Operations in Europe,” *National Defense*, April 5, 2016.

¹⁵ Charles Q. Brown, Jr., Bradley D. Spacy, and Charles G. Glover, III, “Untethered Operations: Rapid Mobility and Forward Basing Are Keys to Airpower’s Success in the Antiaccess/Area-Denial Environment,” *Air & Space Power Journal*, May–June 2015.

7. Joint forward area refueling point: This joint concept is closely related to the U.S. Marine Corps concept of forward arming and refueling point (FARP) operations. The FARP mission is to provide ordnance and fuel for highly mobile and flexible helicopter and fixed-wing operations. The size of the FARP varies with the mission and the number of aircraft to be serviced. Normally, FARPs are transitory facilities used for a specific duration and mission.¹⁶ The Marine Corps also uses another variant of this concept, which is called *Distributed Short Take-Off Vertical Landing Operations*.¹⁷
8. ACE: ACE originally was a PACAF concept that directly informed the command's numbered plan by incorporating a limited number of discrete base types. The term has now been adopted more broadly within the Air Force.

The most-novel and adaptive features of the concepts outlined above appear in the notional operational vignette in the next section.

Operational Vignette

Imagine a scenario in which the United States experiences growing tension with another country or receives unambiguous I&W that an adversary is preparing to attack it or its allies. The U.S. combatant commander might choose to rapidly redeploy forces from a theater main operating base (MOB), which is located inside the enemy targeting range, to a safer rearward base to protect those forces. At the same time, the commander might want to start deploying other forces forward. However, instead of initiating a large and confrontational force deployment to big, traditional bases close to an adversary's targets, the commander chooses to activate and scatter small force packages throughout the theater with just enough capability to initiate operations or prepare those operating locations for forces to flow in later. This wait-and-see-yet-prepare approach minimizes the initial footprint, avoiding provocation and escalation, but retains the initiative for the commander and the President. The commander thus deploys force packages in accordance with unambiguous threats to U.S. bases, weighing the relative operational values, protection and recovery capabilities, and risks.

During the ensuing combat operations, many forces remain based rearward, protected by distance. Some of the rearward aircraft fly long sorties to their intended targets and are refueled by tankers. In other cases, small groups of bases are quickly established forward, organized around hub-and-spoke operations in high-threat areas. As some of these forward bases come under attack, others share resources to help expedite recovery.

Still other combat units are based farther forward, moving from base to base to take shelter at different sites overnight. These movements leave some bases with few combat forces and others with none. If a farther-forward base is attacked (or warned of an attack), its aircraft are ready to

¹⁶ U.S. Marine Corps Warfighting Publication 3-21.1, "Chapter 7: Forward Arming and Refueling Point Operations," *Aviation Ground Support*, October 21, 2002.

¹⁷ Systems Planning and Analysis, Inc., "MAGTF F-35B Distributed Short Take-Off Vertical Landing (STOVL) Operations—DSO Concept of Operations," Alexandria, Va., 2014.

evacuate to safer locations, either to wait or to continue to launch combat sorties from afar. If an attacked base is part of a forward network of bases, then the combat units from the attacked base can regroup and quickly shift to proximal operating locations to continue to fight from nearby. Likewise, repair resources from within the network can be rapidly shunted to bases that need to recover their capabilities, while sortie-generating resources can be shunted to other bases that are on the receiving end of additional combat forces. Meanwhile, the flying units from the attacked base can be informed of the attack while flying and then land at other available bases for service.

As the threat to some of the bases decreases, the ACS resources can be rapidly scaled up at those bases to support more forces, more-sustained operations, or both. In all cases, only those force packages are brought in that will achieve the immediate objectives—no more and no fewer.

Historical Context: From Expeditionary to Adaptive

This operational vignette (and its underlying concepts) presents real challenges to the U.S. Air Force today. In this report, we flesh out the challenges that are specific to ACS, but some historical context should clarify where the Air Force is today, how it got here, and what that implies in moving toward AB concepts.

Over its 70-year history as a separate service, the U.S. Air Force has undergone several shifts in how it employs air power. In its early days, it focused on strategic lift and long-range strike. During the Cold War, it focused on immediate strategic deterrence in the face of a superpower adversary. In the post–Cold War era, it focused on fighter aircraft missions that dominated the competition, and it served as the nation’s preeminent power-projection capability. Throughout its history, the Air Force has adapted to new capability demands, new threat environments, and new technology enablers. Recently, it has made partial progress toward another transition: from a forward-based, in-garrison fighter force to an expeditionary force that can project global power. The time has now come for the Air Force to revisit this last major—although still incomplete—shift.

When the Air Force adopted the Expeditionary Aerospace Force (EAF) concept in the mid-1990s, the intent was to provide air combat power anywhere in the world within 48 hours of notification, leveraging the service’s forward-positioned infrastructure.¹⁸ This new concept forced the Air Force to rethink how it deployed and operated. Deployment force packages, called *Unit Type Codes* (UTCs),¹⁹ were redefined and reconstituted. UTCs and force beddown packages

¹⁸ Competing explanations exist for the exact origin of or motivation for the EAF, but the more or less official history of the EAF can be found at Richard G. Davis, *Anatomy of a Reform: The Expeditionary Aerospace Force*, Washington, D.C.: Air Force History and Museums Program, 2003. See also Robert S. Tripp, Lionel A. Galway, Paul Killingsworth, Eric Peltz, Timothy Ramey, and John G. Drew, *Supporting Expeditionary Aerospace Forces: An Integrated Strategic Agile Combat Support Planning Framework*, Santa Monica, Calif.: RAND Corporation, MR-1056-AF, 1999.

¹⁹ The UTC is a U.S. Department of Defense (DoD) concept, mostly used in the context of deployment transportation data. DoD documentation defines a UTC (or type unit) as “a type of organizational or functional

were made leaner to enable quicker responses. Tactics, techniques, and procedures (TTPs) were revised. The Air Force, after being assigned the responsibility of projecting force anywhere in the world (explicitly “substituting speed for presence”), reengineered its global maintenance and support infrastructure. New support locations were established in forward areas of the world and in the continental United States (CONUS) to enable combat forces to deploy faster with smaller packages yet still provide sufficient capability at the forward positions.

The EAF concept has enabled rapid deployment, but the Air Force has tended to use the concept to operate large numbers of aircraft from positions of sanctuary at heavily supported permanent bases. This tendency resulted largely from the intensive operational demands placed on the Air Force throughout Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). Not until OEF and OIF began in the early 2000s was the Air Force committed indefinitely to so many places at once, affecting such a large swath of the force. Arguably as a consequence of these protracted demands, the Air Force’s transition toward an expeditionary force has taken a course not anticipated by its original planners, and one that is not suited to today’s emerging threats.

Over time, as the surge of rotational deployments became the new normal for the Air Force, the EAF morphed into an effort to stabilize the operations tempo placed on the forces while providing its enduring presence over Afghanistan and Iraq. These deployments were accomplished under a modified EAF concept called *Air Expeditionary Force* (AEF) *rotations*. In the evolution of the EAF concept into the AEF rotation cycle, the pressure of rapidly deploying gave way to a pattern of rotationally deploying, which gave combat and support forces months of advance warning and preparation time to deploy. Although the operations tempo of the rotational deployments remained high, the uncertainty, complexity, and planning for the deployments stabilized and even decreased. Thus, what had begun as an adventurous operational employment shift (i.e., EAF) changed into an administrative force management practice (i.e., AEF) to reduce the strain of ongoing deployments on the force. As a result, the Air Force never fully experienced the impact and challenge of transforming into a rapid-response force as originally envisioned.

Today, the operational and ACS demands of the AB concepts require the Air Force to rethink how to deploy and employ forces. Although the time pressure persists to quickly deploy coherent force packages, the configurations of those packages will need to become much more tailored for the variety of operating concepts being developed for an array of CDO environments and expanding global threats. For all of the reasons described in this section, the Air Force once again needs to reconsider the way it plans, deploys, commands, and invests in its forces so that it can offer future commanders a menu of options for fulfilling the operational and ACS requirements of the alternative AB concepts.

entity established within the Armed Forces and uniquely identified by a five-character, alphanumeric code.” The Air Force has taken the UTC concept to its extreme in terms of granularity and modularity. See DoD, Joint Publication 1–02, *DoD Dictionary of Military and Associated Terms*, Washington, D.C., as amended through February 15, 2016.

Two Broad Challenges

The Air Force faces two broad challenges in pursuing AB concepts. The first is operational—i.e., to understand how AB concepts would function in operational environments, complete with their benefits, limitations, risks, and costs (in resources, personnel, effort, etc.).

Today's challenge for the Air Force is to move beyond what became of the EAF and toward a new concept for force deployment and employment. More to the point, the challenge is to move simultaneously toward multiple, alternative force deployment and employment concepts. The challenge also remains, as in the initial EAF vision, to move beyond *predictable and efficient* deployments to large, fixed, familiar, permanent, heavily protected, and heavily supported bases toward *flexible and responsive* deployments to sometimes small, malleable, unfamiliar, temporary, lightly protected, and leanly supported operating locations.

The second broad challenge is institutional—i.e., to determine where to invest in organizing, training, and equipping the force so that the combatant commanders will have a set of AB concepts from which to choose when engaging adversaries in CDO environments. One theater combatant commander might need investments in traditional base protection, while another might need investments in more-novel concepts, such as operational maneuver. Each set of requirements, which could change over time, would imply different capabilities and thus different investments.

Air Force leaders need to decide which operational and institutional changes would help the force respond best to a variety of combatant commander requests. The ACS implications would extend well beyond the traditional tasks of prepositioning assets, securing host-nation agreements, and investing in base infrastructure at permanent operating locations. The Air Force must address fundamental questions about how to structure its deployment packages, what level of support to provide forward-deployed forces, and what risks to accept so that those forces can survive and continue operating in the midst of enemy attacks.

Importantly, AB largely substitutes one type of risk for another. In the interest of mitigating the risk of being targeted by enemy missiles, commanders will be asked to accept the following types of risks: insufficient sortie generation capacity or sustainability, insufficient capability to prevent or recover from ground attacks or accidents, and human performance degradation. The relative favorability of these trade-offs is not yet well understood. Fully accounting for these risks is beyond the scope of this report, but is a topic that deserves serious attention. As planners and commanders better understand how the various tools in the AB toolkit function, they must also understand the incumbent risks to make informed trade-offs.

Goals of This Report

This report aims to answer the following questions:

- What is AB, and what are its new ACS requirements?

- How should these new ACS requirements be modeled and estimated?
- What does the model tell us about the ACS footprint sizes?
- What obstacles would the ACS community face in fulfilling the requirements for AB?
- What should the ACS community and the Air Force do to overcome these obstacles?

The situation today is that operational planners are developing alternative AB concepts to accomplish operational objectives, and they require ACS logisticians to help collaboratively develop support concepts. The Air Force has begun to engage the operational, planning, and ACS communities in this collaboration. An additional goal of this report is to contribute to that ongoing dialogue.

Organization of This Report

Given the brief description of the AB umbrella and AB concepts in this chapter, in Chapter Two, we introduce *ACS competencies* to enable AB. These competencies are traditional ACS capabilities combined and modified in ways that could support the operational objectives to which AB aspires. We then briefly describe the ACS requirements demanded by the concepts of integrated basing, flexible operations, and rapid scalability.

In Chapter Three, we explain the mathematical model we used for estimating the ACS footprint requirements of the core AB concepts. Two themes cut across most of the alternative AB concepts: small force package size (i.e., footprint) and speed. We thus designed a model to assess the ACS footprint implications of the core AB concepts.²⁰

In Chapters Four, Five, and Six, respectively, we present extended discussions of the three types of ACS requirements introduced in Chapter Two. We use the models from Chapter Three to estimate each set of requirements. We itemize the estimated requirements, and each chapter concludes with a discussion of the obstacles to fulfilling each competency.²¹

Finally, in Chapter Seven, we outline our overall implications and recommendations and point to a way forward for the ACS community and the Air Force as a whole to develop and implement AB.

²⁰ We built a separate model to assess the ACS transportation time required to move the ACS force packages, which will be described in forthcoming research by Anna Jean Wirth and Jonathan Welburn.

²¹ The estimates do not present definitive answers to the urgent questions about logistical requirements, total force capacities, or costs, but they do illustrate the kinds of trade-offs that ultimately will need to be made.

2. Adaptive Basing and Its Enabling Agile Combat Support Competencies

All of the AB concepts, both static and adaptive, are geared toward making the Air Force capable of deploying to a forward-contested environment, avoiding or surviving an adversary attack, recovering, and then delivering combat air power to support a combatant commander's mission. A commander might or might not choose to use many of the static practices at a given location or in a given scenario. These choices would influence the cost of establishing locations, the time required to do so, and the survivability of the bases and networks.

So how could the Air Force attain this radical vision of integration, flexibility, and responsiveness? In this chapter, we emphasize the potential of three operational concepts requiring new ACS competencies that would be fundamental to the adaptive side of AB: integrated basing, flexible operations, and rapid scalability. These three ACS competencies and associated metrics will serve as the focus of our ACS requirements estimates in chapters to come. Although the estimated ACS requirements exclude much of what falls under the broad AB umbrella, we believe that they encapsulate the essence of what ACS could contribute to AB.

Operating adaptively would require the same ACS capabilities and activities as before, but it would require some of them to be performed differently. We differentiate between *capabilities* and *competencies* (i.e., traditional capabilities used in unique ways). The ACS community has the capability to support independent bases, but it needs to develop the competency to support integrated-basing networks. The ACS community has the capability to generate combat sorties from a single fixed location, but to support AB, it requires the competency to generate combat sorties from multiple flexible locations. The ACS community has the capability to build bases, but it lacks the competency to rapidly scale the capabilities of bases during conflicts.

What AB requires is that the ACS community build networks of integrated bases, generate sorties from those bases using dispersed maintenance assets for flexible operations, and rapidly scale the capabilities of those bases in response to changing conditions. By fulfilling these requirements, the ACS community would help ensure that the Air Force could deploy to dissimilar CDO environments, survive attacks, and continue to operate. This report represents a concerted effort toward helping the Air Force and its ACS community rise to these challenges.

Cross-Cutting Agile Combat Support Competencies of Core Adaptive Basing Concepts

From the collection of today's leading AB concepts, as synthesized in the operational vignette described in the previous chapter, we identify three cross-cutting sets of ACS competencies that bound today's leading concepts and are needed to enable AB. The three ACS

competencies are operating from integrated basing, conducting flexible operations, and rapidly scaling bases up or down.

Integrated bases would be the necessary launchpads for flexible operations and rapid scalability. As noted earlier, these three ACS competencies enable only the adaptive side of AB, not the static side of AB activities that also would support AB in a broader warfighting toolkit.

Because the trio of new ACS competencies encapsulates the essence of what ACS can contribute to the adaptive side of AB, it will be the focus of the remainder of this report. To begin, we briefly describe the rationale behind each of the competencies of integrated basing, flexible operations, and rapid scalability for CDO environments, and we link each rationale to how they enable the adaptive AB concepts.

Integrated Basing

Air Force units historically deploy to a single forward base that provides a complete complement of the support needed to conduct combat operations. Such *independent* bases are sufficient when the threat of attack is low. In a CDO environment, however, these solitary bases can become prime targets for enemies seeking to disrupt and disable U.S. operations with a single missile attack or a series thereof. An attack on a solitary, forward base can cripple an abundance of critical resources and dismantle combat operations in a particular theater.

Therefore, adaptive AB concepts envision the Air Force operating from networks of *integrated* locations. The designs of these AB networks range from clusters to hub-and-spoke operations to shell games. Each network design would strengthen certain AB concepts but also would incur costs, most notably the periodic movement of equipment and personnel.

How commanders use various network designs likely would differ. Some theaters might offer a wide selection of airfield inventories, providing more options for the basing networks. Other theaters might offer significant variability in the quality and capability of the available bases, which could dictate the design of the basing networks. Either way, the cultural and operational shift for the Air Force as a whole would relate to the reliance on *other* bases in each network for certain types of ACS. In other words, the AB operational resilience derived from ACS would emanate from a *group* of bases rather than from highly protected solitary bases.

Flexible Operations

Traditionally, combat fighter aviation units deploy with their maintenance units from the same wing, and both units operate from a single established base for an extended period of time. There is little movement of aircraft from one location to another. When there is, the fighter unit's maintenance crew relocates with the aircraft. The long-accepted notion is that the maintainers from the wing know the pilots and the aircraft best, and there is value in the trust and teamwork gained from deploying into combat with the people you know and work with day-to-day. Such unit association has been the standard for years.

However, most of the adaptive AB concepts require regular movements of aircraft among bases. Historically, such maneuvering of aircraft would require additional unit resources to honor the unit integrity across a greater number of operating sites. This unit integrity would imply the provision of both flightline and backshop maintenance at each and every AB operating location.

Instead, the adaptive AB concepts that demand regular movement of aircraft among integrated bases in CDO environments would call for the decoupling of flightline maintenance (refueling, rearming, and simple repairs) from backshop maintenance (such as protracted engine overhauls). Flexible operations would place a premium on short servicing times, small footprints, and cross-servicing (in which a maintenance function is performed by one military service in support of another). In the Air Force, the airlift and tanker units already employ some of these decoupled maintenance concepts, but they would be new for fighter aviation units.

One key cultural implication of this new ACS competency for flexible operations would be to have combat aircraft routinely serviced by maintenance personnel from other units—the notion being that the personnel and equipment needed to generate combat sorties for a given mission-design series (MDS) fleet of aircraft should be certified and authorized to maintain any of the MDS aircraft for which they are certified, regardless of the aircraft’s home unit. Similarly, the maintainers who are needed to generate, launch, and regenerate combat sorties should be capable of being placed at any operating location; generating the sorties; and refueling, rearming, and repairing aircraft from the same MDS that happened to land at the location.

Today, for example, when any base transient alert (TA) unit receives a transiting aircraft, the unit can refuel the aircraft and send it on its way. For the mobility airlift community, this approach already is common practice in the enroute system. The ACS community would need to adopt this practice for fighters in AB.

Rapid Scalability

Some truly adaptive AB concepts demand rapidly scaling up or scaling down the operations at one or more bases in theater. This is not something the Air Force has historically done during a contingency. Rather, the Air Force traditionally has planned a deliberate, predictable buildup of forces. In recent and ongoing rotational operations, this buildup has involved a long-term force beddown to support a long-standing, stable population of warfighters and a firmly planted combat force footprint. Plans for major combat operations have called for somewhat faster buildups, but recent research shows that even those buildups have followed a predictable rhythm and pace.²²

²² Patrick Mills, Caolionn O’Connell, Kristin F. Lynch, John G. Drew, Louis W. Miller, Kristin Van Abel, Peter Buryk, Carter C. Price, and Paul Emslie, *Analysis of U.S. Air Force Surge Capacity for Aircraft Availability: Costs, Challenges, and Opportunities*, Santa Monica, Calif.: RAND Corporation, 2016, Not available to the general public. This report identifies a rather direct relationship between the size of Air Force forces ultimately bedded down and the amount of time required to deploy those forces.

In CDO environments, where beddowns could be located inside enemy missile ranges, forces might rely on smaller forward footprints in the early stages of a conflict, when the potential for attacks would be higher. The intent would be to reduce the number of forces and the amount of resources subject to injury and destruction early, yet retain the option to increase the capability and capacity of the forward fighting positions once the threat had waned. To support operations in this way, the ACS community would need to be able to rapidly expand the capability of a base.

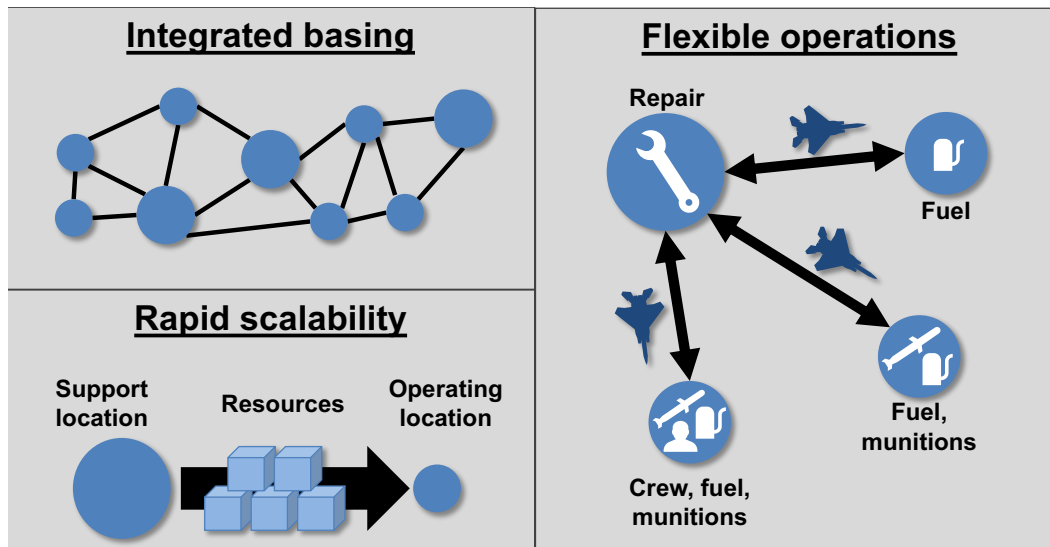
Similarly, if forces sought to maneuver on a regular basis among a network of integrated bases, the ACS resources might need to be shifted among the networked locations as dictated by the campaign plan and the desire to use different bases for different purposes during different campaign phases. The ability to quickly upgrade or downgrade the ACS capacity and, thus, the operating capability of the bases, would be critical to all phases of the campaign.

Flexible operations and rapid scalability represent two ways in which a commander could use integrated-basing networks. Whereas flexible operations would require an ACS operations and maintenance function for dispersing flightline maintenance throughout the basing networks, rapid scalability would require an ACS mobility function for scaling the networked bases.

Envisioning the Resource Requirements of Agile Combat Support Competencies That Enable Adaptive Basing

Figure 2.1 illustrates the distinctive ACS competencies of the adaptive force deployment and employment concepts discussed throughout this report. The upper-left panel shows that the foundation for many AB concepts would be their reliance on an integrated group of bases rather than on solitary bases. Therefore, the ACS resources would need to be comparably dispersed and integrated. The panel on the right illustrates how the ACS operations and maintenance function would work differently than it does today: by dispersing varied flightline maintenance capabilities to the integrated bases and by decoupling those capabilities from backshop repair, which would be available at only a shared rearward hub. The lower-left panel shows that the ACS mobility function would be critical to ensuring the rapid scalability of the integrated bases. As the mission or threat dictated the capability of each, bases in the integrated construct might scale up or down.

Figure 2.1. Integrated Basing, Flexible Operations, and Rapid Scalability



One can think of these three competencies as ACS building blocks that could support a variety of agile, survivable operating concepts. Without knowing exactly which operational concepts will be called for and when, the ACS community can nonetheless assess what these building blocks imply for its own force development.

Next Steps

In Chapter Three, we explain the analytic approaches—i.e., the footprint and transportation models—that we used to quantitatively estimate the resource requirements for the three ACS competencies of integrated basing, flexible operations, and rapid scalability. Chapters Four, Five, and Six will present the resulting estimates for each of the three in turn.

3. Estimating the Resource Requirements for Agile Combat Support Competencies

To estimate the resources required to support the ACS competencies of integrated basing, flexible operations, and rapid scalability, we built a model to calculate the footprint requirements implied by the concepts. This model estimates the ACS footprint that would need to be put in place to make each concept operational.

We developed several AB analytic cases as tools for assessing the resource requirements of the adaptive force deployment and employment concepts. We designed the cases (and defined their metrics) to represent common operational objectives, such as increasing airlift or throughput capacities, increasing the amount of prepositioned equipment, choosing more-capable bases and/or partners, or sizing and sequencing deployments more deliberately. We also considered common AB operational risks, such as accepting less capability to respond to attacks or accidents, and other trade-offs, such as accepting more-austere living conditions.

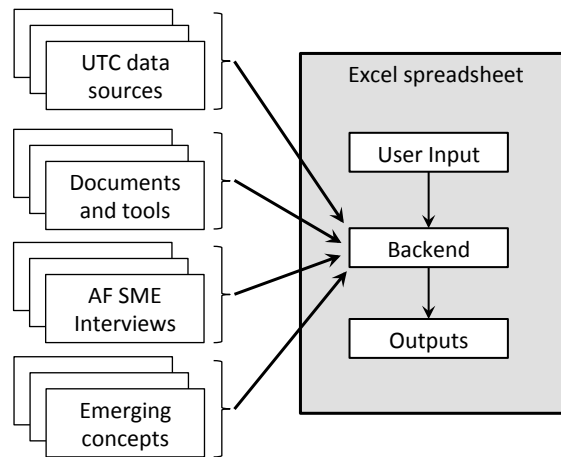
The rest of this chapter will describe the footprint model at the heart of this analysis: the Lean Strategic Tool for the Analysis of Required Transportation (Lean-START).

Footprint Model: Lean-START

Lean-START is an Excel-based spreadsheet tool that allows for rapid iteration between the user inputs, which represent a force's desired combat capability, and the outputs, which represent the ACS resources required to sustain the fighting force. The left side of Figure 3.1 shows the four categories of underlying source data that serve as the engine driving the Lean-START tool.²³ Essentially, the underlying source data represent the baseline collection of approved planning factors that the Air Force uses to plan and execute combat operations and their support requirements. The right side of the figure shows that the user inputs, when combined with the collection of underlying back end data, generate the ACS outputs (or requirements).

²³ For more information on the Lean-START model, see Patrick Mills, James A. Leftwich, Kristin Van Abel, and Jason Mastbaum, *Estimating Air Force Deployment Requirements for Lean Force Packages: A Methodology and Decision Support Tool Prototype*, Santa Monica, Calif.: RAND Corporation, RR-1855-AF, 2017.

Figure 3.1. Lean-START Source Data, Inputs, and Agile Combat Support Outputs



NOTE: AF SME = Air Force subject-matter expert.

Underlying Data Sources

For the first category of underlying data, we drew from several UTC data sources to obtain the official data that the Air Force uses to express its deployable capabilities and their movement requirements. These sources are the manpower and equipment force package (MEFPAK), mission capability (MISCAP) statements, the logistics detail (LOGDET), and the manpower force package system (MANFOR).

For the second category of underlying data, we drew from official and unofficial Air Force documents and tools related to footprint requirements. Some Air Force functional areas benefit from official publications (e.g., instructions, manuals, or pamphlets) that periodically distribute updated planning factors. Other functional areas rely on less official sources; for example, the Civil Engineer Supplement to the War and Mobilization Plan, Volume 1 (WMP-1) cites the conditions under which various UTCs deploy and denotes their levels of capabilities.²⁴

For the third category of underlying data, we conducted focused interviews with numerous Air Force subject-matter experts (SMEs) from HQ PACAF, HQ USAFE, HQ Air Combat Command (ACC), and HQ Air Mobility Command (AMC). These meetings helped us clarify ambiguities in the documents and tools and dig deeper into the deployment logic. For instance, because we often were decomposing UTCs into their constituent parts, we had to understand what drove the deployment of individual skill sets and equipment types, something that rarely was explained in the documentation itself.

For the fourth category of underlying data, we drew on the alternative AB concepts being explored across the Air Force, such as Rapid Raptor, Rapid-X, and untethered operations. All of

²⁴ U.S. Air Force, *War and Mobilization Plan, Volume 1 (WMP-1), Basic Plan and Supporting Supplements: Civil Engineer Supplement*, Washington, D.C., 2016a.

these concepts have elements that are intended to increase the survivability of the Combat Air Force (CAF) (particularly fighters) by disaggregating operational units into smaller components, streamlining maintenance operations, and varying the levels of aircraft-servicing capability across the integrated-basing networks—all of which would contrast with the status quo: deploying fighter units to large, fixed bases with robust maintenance support to generate high volumes of sorties over sustained periods.

Once we gathered the four categories of underlying data, we synthesized the data into deployment rule sets that we fed into Lean-START. The most-valuable contribution of Lean-START to footprint modeling is the tool’s collection of embedded deployment rule sets, as derived from the underlying data. When we refer to *rule sets* or *deployment rules* or *deployment logic* (which we use interchangeably), we mean one of two things. One set of deployment logic applies to aircraft—aviation, aircraft maintenance, and munitions maintenance—and contains mathematical formulas that translate user inputs into personnel and equipment requirements. These rules were developed by decomposing these UTC series (i.e., 3- and H-series) into their constituent parts and using a combination of SME input and regression analysis to develop mathematical relationships between inputs and outputs. Each aircraft type has a unique set of equations for both personnel and equipment.

The second type of deployment logic operates at the level of whole UTCs and applies “if-then” statements that link the existing conditions or desired capabilities at an operating location to one or more UTCs that contain the personnel and equipment necessary to deliver the user-specified conditions or capabilities. In Table 3.1, we show some examples of this if-then logic from the model.

Table 3.1. If-Then Statements Typical of Lean-START Rule Sets

Condition (If)	Requirement (Then)
Aircraft type is F-35	Send eight firefighting crews and five P-19 trucks
CBRN threat is high	Send prime BEEF EM 4F9W-series UTCs consisting of 18 personnel and 47 tons of equipment
Base population is 1,500 to 3,000	Send the EMEDS basic medical package

NOTES: Each UTC is represented by a five-character alphanumeric code (e.g., 3FKS1, HFKS1). CBRN = chemical, biological, radiological, and nuclear. BEEF = Base Engineer Emergency Force. EM = emergency management. EMEDS = Expeditionary Medical Deployment System.

User Inputs

A Lean-START user proceeds through three stages of inputs. In the first stage, the user enters inputs for the operational scenario. The user specifies the numbers and types of weapon systems to be employed (e.g., F-22s, F-15s, F-16s, C-130s), the daily flying profile for those systems (i.e., the number of sorties per aircraft, the duration of the sorties, and the type of

munitions being flown), and the number of days of flying operations.²⁵ These inputs drive the demand for combat resources in the areas of aviation (pilots and other mission personnel), aircraft maintenance (flightline and repair personnel working directly with the aircraft, its components, and aerospace ground equipment), and munitions maintenance (personnel to account for the munitions, build them up, and transport them to the front line).

In the second stage, the user enters inputs for nonmaintenance ACS, which is also known as *beddown planning*. These inputs pertain to the inherent characteristics of the operational location and the desired level of ACS capabilities to sustain the operation from that location. These capabilities include fuel, security forces, firefighting, medical care, and communications.

In the third stage, the model allows the user to tailor the ACS requirements based on information about prepositioned equipment, host-nation support, contract support, and risk tolerance. The tailoring of requirements applies to both maintenance and nonmaintenance ACS.

Agile Combat Support Outputs

The tool generates aggregate mobility requirements in terms of personnel, equipment, and aircraft, along with detailed lists of these requirements in terms of UTCs. The UTCs represent highly modular sets of force packages that the Air Force has developed for the purpose of specifying the precise amount of personnel and equipment required for each unit of operational capability. Because the Air Force organizes its deployments in terms of UTCs, the Lean-START model generates a list of the UTCs needed to support a mission, with the exception of the maintenance UTCs. In the case of the maintenance UTCs, Lean-START can produce a list of the personnel and equipment needed to support the aircraft and the desired operational capability. The model also computes the sum of the weight of those UTCs (sometimes referred to as the *footprint*) and the number of aircraft needed to move the UTCs to the location from which the mission will be executed.

Given these ACS outputs, the user can iterate to change any of the three stages of inputs to explore the tradespace of options. In this way, Lean-START permits the user to evaluate the trade-offs between speed and capabilities (in terms of UTCs).

The ACS outputs generated by the tool generally fall into one of three categories: those that support the operational flying mission, those that provide safety and security for the aircraft and people, and those that support the care and feeding of the people. (The first output category is maintenance ACS, whereas the second and third output categories are nonmaintenance ACS.) For each of the three ACS output categories, the user can specify the level of capability desired, working from a baseline that is computed as a function of the amount of infrastructure available at the beddown location.

²⁵ Lean-START accepts any nonzero value for the duration of flying operations, but in determining aircraft-related requirements, it differentiates only among the following categories: one day, two to seven days, eight to 30 days, and more than 30 days.

The level of capability the user specifies generally affects two outcomes: the overall amount of people and equipment that should be deployed and the accepted amount of risk to mission, safety, security, and personnel. If the user reduces capability (and footprint) in one or more areas to deploy more quickly, then the user generally reduces the ability to mitigate risk to mission execution, aircraft, people, safety, security, or care and feeding of personnel.

Although Lean-START is a strategic tool that takes a first-order look at ACS resource requirements for analytical use, it is not a replacement for detailed deployment planning by an SME. Lean-START will produce a general force list, but it does not time-phase requirements or resource movements. The tool also does not capture requirements for very small (i.e., one-to-three-person) general base operating support (BOS) UTCs, which, even in the aggregate, have minimal impact on the force beddown footprint.

Chapters Four, Five, and Six will apply the Lean-START model to describe the resource implications of the three ACS competencies described in Chapter Two. The analytic cases selected for these chapters represent the application of the ACS competencies of integrated basing, flexible operations, and rapid scalability, respectively.

4. Resource Requirements for Integrated Basing

The first half of this chapter describes the concept of integrated basing. The second half of the chapter describes the construction of integrated-basing networks, complete with an estimation of benchmark resource requirements for those networks under varying conditions.

In the conceptual first half of the chapter, we discuss traditional basing approaches and explain how integrated basing would differ from those approaches. We then discuss how integrated basing would support AB and how various categories of ACS could support integrated basing. This discussion underscores that there are many types of operating locations that could contribute to integrated-basing networks and many types of ACS that could support those locations.

In the constructive second half of the chapter, we propose a way to help the Air Force manage the myriad integrated-basing options and their associated resource requirements. We show how the Air Force could quickly construct integrated-basing networks from the building blocks of just four base archetypes. The particular characteristics of these archetypes can be fashioned and tailored to suit the unique demands required by each operating location.

The goal of this chapter is to point the Air Force toward the swift construction of integrated-basing networks and the swift estimation of their resource requirements. We propose that the four building blocks (or base archetypes) can suffice for constructing numerous types of networks and for estimating their resource requirements in readily quantifiable yet ultimately customizable ways. The chapter concludes by outlining the obstacles to fulfilling these requirements.

Traditional Basing Approaches

Traditional beddown planning for operational locations is fairly straightforward. The bases in the beddown are designed to operate more or less independently. Although they are connected to a common supply chain for deployment and resupply, most bases are sized and resourced to conduct aircraft operations and a wide variety of base support functions with on-base personnel and equipment.²⁶

Most traditional bases also are sized and resourced to conduct sustained, robust operations. By *sustained* and *robust*, we mean for more than 30 days, which raises quality-of-life

²⁶ Even nominally independent bases are somewhat interdependent. Operating locations exchange personnel, equipment, and supplies with one another as situations dictate. However, operating locations are not designed differently for that purpose, and they do not rely on one another to generate capability and capacity. Thus, they are not truly integrated. Likewise, repair networks at independent bases often are established, even in wartime, to bring some economies of scale to component aircraft maintenance.

expectations that usually necessitate the full suite of BOS amenities (housing with environmental control; shower and shave facilities; hot meals; laundry; and morale, welfare, and recreation [MWR] activities). Most of the equipment weight for a deployment of this nature is driven by the BOS equipment and vehicles, and most of the BOS weight is driven by traditional design parameters for sustained, robust bases.

How Integrated Basing Would Differ from Traditional Approaches

Several characteristics would differentiate integrated basing from traditional basing. One characteristic is the lower density of aircraft per location. More-dispersed beddowns, although not unique to AB, often are emphasized in AB. Another difference would be unevenly resourced bases. Various AB configurations deliberately give some bases less capability, capacity, sustainment, or resilience, either to lower the cost of opening more locations or to offer less attractive targets. Ultimately, the key differentiator would be the intent to use bases in an integrated way.

There are two types of integrated operating locations: complementary capability and equal capability locations. Complementary capability locations within a basing network often lack capabilities that another location is meant to provide. Typically, such a network includes a highly functional operating location and one or more locations with only partial support capabilities. A base with substantial support capabilities in a lower-threat, rearward location might be paired with forward sites that provide partial support (for example, rearm and refuel) to allow aircraft to extend their range. Another example of complementary locations is the hub-and-spoke concept. A hub is a highly capable location, while the spokes serve as divert locations for use should the hub get attacked. Aircraft can recover at the spoke locations while the main hub reconstitutes. Equal capability locations within a basing network also can share resources. This sharing often is facilitated when the operating locations are physically close to each other, as with the cluster-basing concept. The bases could be able to share security, logistics, and other capabilities.

Complementary Capability Locations

Forward Arming and Refueling Points

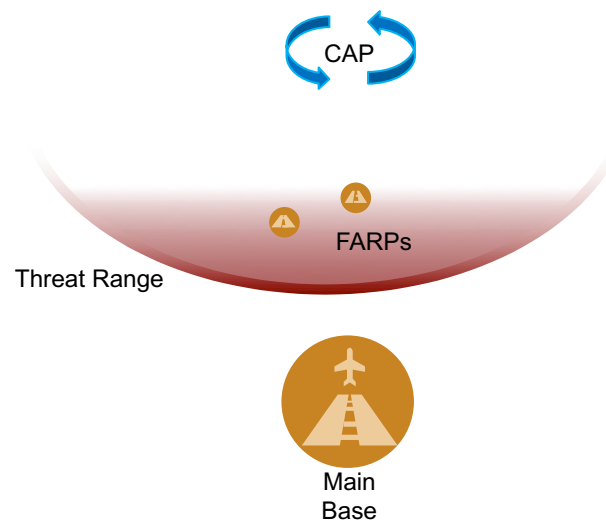
One example of a complementary, integrated operating location is a FARP.²⁷ This concept pairs a high-capacity rearward location with one or more forward arming and refueling locations to extend the combat potential of the aircraft (see Figure 4.1).²⁸ In most cases, only the rearward

²⁷ We choose the term *FARP* because FARP is a joint term and is practiced by all of the services. FARP also has been defined as a forward *area* refueling point. Joint Publication 3-09.3 defines FARP as “a temporary facility, organized, equipped, and deployed to provide fuel and ammunition necessary for the employment of aviation maneuver units in combat” (DoD, 2018).

²⁸ *High-capacity rearward location* refers to an operating location in a lower-threat area farther away from threats.

operating location will have sufficient resources to support sortie generation for an extended period. The design of the forward location is based on a combination of threat assessment, desired sortie generation capacity, and acceptable risks.

Figure 4.1. Integrated Standoff Location and Forward Arming and Refueling Points



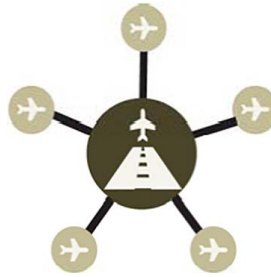
NOTE: CAP = Combat Air Patrol.

The FARPs allow aircraft to operate primarily from standoff while buying back some efficiencies by sometimes operating forward. If fuel is available on the ground, the FARPs offer efficiencies in in-flight refueling and mitigate the risk of forward attacks by presenting small, fleeting targets. Nevertheless, they do give the adversary a chance to target the forward aircraft. Essentially, a FARP takes aircraft from a low-threat location and exposes them to attack at a forward location. Whether a location comes under attack depends on the targeting agility of the adversary and their calculation about the value of that target relative to other possible targets. If the Air Force were to choose to employ such a concept, it should carefully weigh the potential value (e.g., decreased in-flight refueling demand, decreased crew time, increased sortie potency from rearming more quickly) against the possibility of attack and not assume that the small footprint and temporary nature of the FARPs would eliminate that possibility.

Hub-and-Spoke Locations

The hub-and-spoke concept of integrated basing usually has at the center a single hub, a base with extensive capabilities to generate sorties and support aircraft. Linked to this hub are several smaller, less-capable spokes. Figure 4.2 depicts a notional hub-and-spoke configuration.

Figure 4.2. Hub-and-Spoke Locations



The hub-and-spoke concept is different from the FARP concept in that the hub is under the same threats as the spokes and is not located farther away in a lower-threat area. Instead of providing standoff, the hub-and-spoke concept adds redundancy and resilience that provide escape options before or after an attack and that increase the overall number of weapons needed by an adversary to achieve the same effect of suppressing sortie generation. The hub and spokes would challenge the adversary's intelligence, surveillance, and reconnaissance (ISR) assets because the adversary would have to continuously monitor the disposition of aircraft among the integrated, forward airfields.

The hub and spokes would drive needs for early warning of attack and for an ability to flush aircraft from the hub so that they would not get destroyed or stranded. With its space-based ballistic missile launch warning systems, the United States can detect cruise missiles using airborne sensors, but these systems can be degraded during a conflict. The ability to flush aircraft on such a warning—which might come only minutes before an attack—likely will prove difficult at forward combat bases.²⁹ In this scenario, pilots already will be flying very taxing missions from these locations; asking them to stand on alert for warning of missile attack will add considerably to their duty time. Even if additional aircrews are devoted to the locations, the aircraft on the ground likely will be undergoing some form of maintenance; in many situations, it will not be possible to disengage from these repairs to ready the aircraft for takeoff within the allotted time.

An alternate concept would have aircraft rotate between the spokes and the hub, operating for a time at the spokes, moving to the hub for more-intensive repairs, then returning to the spokes. Alternatively, the aircraft could remain at the spokes, and maintenance teams could be sent there for repairs. In either case, more locations means more targets and thus diffuses the effects of each attack. Operating from the start from the spokes (even in part) relieves the burden of flushing aircraft to escape an impending attack, which often is a difficult and costly proposition.

The Air Force would need to choose the level of support at the spokes, depending on their purposes. The more capable the spokes, the more combat power can be generated after attacks on

²⁹ If fighter aircraft are on alert, it might be possible to get only a limited number off the ground before a missile impacts, given that pauses between takeoffs must be inserted to allow vortexes, which are created at the end of the runway by departing aircraft, to settle and ensure safe takeoff for subsequent aircraft.

the hub. However, more-capable spokes are costlier and make more-valuable targets. At a minimum, spokes require the ability to turn aircraft (i.e., they need minimal fuel and maintenance personnel and some other ground crews). This ability would enable aircraft to wait out an attack on the hub and return to the hub once it recovers. If the spokes have the capability to launch full combat sorties (i.e., rearming), then missions could be conducted from the spokes for a limited duration.

Equal Capability Locations

Cluster Basing

The cluster-basing concept calls for limiting the force package size of combat aircraft and investing in the resilience of each location to reduce the effectiveness of attacks on any location.³⁰ A cluster of integrated bases would present locations with fairly equal capability and resilience so that the attacker would not have the luxury of focusing on high-value assets, but instead would have to spread resources among numerous high-value locations. Some key resilience features that are hallmarks of this concept are on-base dispersal of aircraft (that is, adding parking areas so that no single weapon could place multiple aircraft at risk on the ground), resilient fuel storage, and advanced runway repair capabilities.

When possible, operating locations should be close to each other to facilitate resource sharing and to focus logistics support. Cluster basing could involve some movement of aircraft among the bases, but the intention would be to operate resiliently from each base.

The number of aircraft at each location would be based on the level of perceived threat and the desired combat power. Cluster basing would create very resilient operating locations, but in many cases would require a substantial investment in materiel and equipment.³¹ A cluster-basing network also might require more time to establish, unless host nations would be willing to make some of the infrastructure resilience enhancements in peacetime.

These investments of time and resources might be worth making if a conflict is expected to be fairly intense and last more than just a few days. This is because ballistic and cruise missiles are wasting assets: They are not easily replaced, and, once exhausted, the Air Force would have the opportunity to increase its operations from closer areas that were previously under threat and thus increase the sortie potential of every aircraft compared with the standoff options.

³⁰ The Air Force describes a high-level concept for cluster basing in various AB briefings and documents. The concept for cluster basing described here is based on RAND research conducted in 2014 that is not available to the general public.

³¹ The preexisting physical plant and desired capability at each location ultimately will determine the total investment needed. In the original RAND cluster-basing concept, all locations have the same level of capability, but in practice, some capabilities, such as the level of backshop maintenance, could vary from location to location.

Shell Game

A shell game is another example of equal capability operating locations. Its salient feature is the use of movement to complicate—and, ideally, evade—enemy targeting by moving aircraft dynamically from location to location. In our version of the shell game, more operating locations are created than necessary, and aircraft operate for a period from one set of bases before moving to another set. The movement needs to be unpredictable so that the adversary is forced to have a tight kill chain to target the aircraft, lest the adversary attack an empty base.

The air commander would need to weigh the number of resilience investments made at each location against perceptions of the adversary targeting cycle and the importance the adversary places on disrupting operations from specific areas. A shell game would use more resources per aircraft compared with more-static concepts of operation because of the requirement to create more operating locations than would be used simultaneously.

The efficacy of a shell game would be tied to the accuracy and agility of the adversary kill chain. The more accurate and nimbler the adversary's kill chain, the more likely the effort to outmaneuver attacks would be not only futile but also counterproductive because additional resources would be spent on the movement of aircraft instead of the generation of aircraft. If the adversary were agile enough to target aircraft consistently in the shell game, then the commander would be better off not using a shell game at all, but instead dispersing the aircraft across all the locations in a more-static arrangement.³²

How Integrated Basing Would Support Adaptive Basing

Anti-access capabilities are problematic for the Air Force because they expose U.S. operating locations to attack and tend to push those locations farther away from operating areas. Increasing the ability of the Air Force to share resources could counteract some of these negative implications. Sharing resources among integrated bases would provide the flexibility to

- extend combat reach
- make the Air Force more resilient
- make more-effective use of resource capacity.

How Agile Combat Support Could Support Integrated Basing

Whereas traditional ACS provides the classic capabilities of establishing, operating, sustaining, and protecting bases (usually from ground-based threats), the additional ACS roles

³² For a limited exploration of the impacts of adversary observe, orient, decide, act (OODA) loop timing, see Daniel M. Romano, Anthony DeCicco, Robert A. Guffey, Rachel Costello, Katherine Pfrommer, Christopher Lynch, Patrick Mills, Andrew Karode, Devin Tierney, Brent Thomas, and Robert S. Tripp, *War Reserve Materiel Prepositioning and Force Maneuver Options to Ensure Air Operational Resiliency in Denied Environments*, Santa Monica Calif.: RAND Corporation, 2016, Not available to the general public.

for integrated basing would be mainly in the planning process—i.e., in the science and art of designing bases to operate as a network, with shared resources for aircraft repair and other forms of support. The following examples of shared ACS for integrated basing will factor into our estimates of the resource requirements for the base archetypes (except as specified in the following sections).

Shared Aircraft Repair

A footprint can grow very large when supporting sustained operations at a traditional base because planners must prepare to address lower-frequency maintenance issues. Certain repair functions require a large footprint but address infrequent maintenance demands. Shared maintenance resource concepts try to address these higher-cost, lower-frequency demands. The Air Force ACS community could expand on two existing options to satisfy these demands through shared aircraft repair: (1) forward, centralized repair locations and (2) deployable aircraft repair teams. These options are used more commonly with the Mobility Air Force (MAF) and could be applied more widely to the CAF. In particular, MAF aircraft, which often have longer maintenance cycles and can fly farther unrefueled than CAF aircraft, rotate back to rearward repair locations for heavy repair and planned inspections.

A forward, centralized repair location could offer low-observable (LO) maintenance. LO maintenance requires a large footprint for low-frequency repairs. However, because a compromised stealth capability does not hinder the airworthiness of an aircraft, it is feasible for the aircraft requiring LO maintenance to move from one location to another for repairs.

The concept of sharing maintenance capabilities for large-footprint, low-frequency aircraft repairs is practiced by the Air Force's strategic airlift forces through the employment of maintenance repair teams (MRTs).

Other Shared Support Capabilities

The following items include many types of equipment and personnel that would be well suited for centralization among a group of integrated bases:

- spare parts
- quick reaction forces (QRFs) (combined with local security at each location)
- transportation (air, land, or sea)
- area missile defenses
- construction engineering (depending on time demands)
- medical support (combined with local immediate care).

Shared spare parts. Spare parts are an excellent example of a resource that is likely to be more beneficial when shared than when dispersed to each site. Deciding what spare parts to send with small detachments of aircraft can be difficult. Sending too few parts will hamper maintenance efficiency, while too many can inflate the cost of provisioning several small units and could lead to shortages elsewhere. Lateral moves—when a spare part is transferred from one

operating location to another rather than from the depot to an operating location—already occur, but even so, each flying unit’s spares package is computed as if the unit will operate alone. The concept of a network of locations sharing spare parts would alter the computations of these spares packages: At least some parts would be sent with the intention of fulfilling demands from several forward operating locations.³³ One way to estimate the savings would be to compare, for a given number of aircraft, the spares package that would be distributed for the total number of aircraft if they were deployed to one location with the spares packages that would be distributed to each aircraft at separate locations.

Shared QRFs. Airfield security could be handled in many different ways, depending on host-nation support and joint activity at an airbase. Even in areas where the likelihood of attack is deemed very low, some level of security will be required to prevent intrusions onto the base. Designating a QRF to support a group of bases within timely deployment range of the QRF could be a sensible way to provide effective, shared security.

Shared transportation. A variety of aircraft, trucks, and ships could be used to support Air Force operations in CDO environments. Although the analysis in this report tends to denominate the lift demands in terms of C-17 equivalents, it is likely that many other types of lift assets would be used, depending on the geography and other lift demands of a conflict. Some of these mobility assets could be used to bring supplies to each location, while others could be used for deployment and potential movement from one location to another beyond the initial deployment. If dynamic movement needs to happen on a large scale and/or frequently, lift assets might need to be dedicated to units or certain bases to ensure timely support. Each location might not need dedicated airlift, but a group of locations might need airlift to serve all of the locations on a rotational basis. To the extent that surface assets (ships and trucks) would be appropriate, they might come from the joint force, host-nation support, or contractors, but they also would require highly responsive arrangements. Furthermore, the number of transportation assets and cross-site sharing arrangements would be subject to distance and other logistical requirements. (Because many of these shared transportation assets likely would come from outside the Air Force, we will exclude them from our estimates of resource requirements for the base archetypes.)

Shared area missile defenses. In a small number of cases, area missile defenses could be considered shared assets. Currently, the two missile defense systems that are most relevant are the Patriot Advanced Capability-3 (PAC-3) and Aegis Ashore, but both have numeric constraints that would prevent their widespread use to protect airbases. The operating locations also would need to be close enough to fit within the defended footprint of the systems. Specifically, the bases would need to be within tens of nautical miles of each other to be candidates for shared missile defense coverage. (Given the limited inventory of missile defense systems and the dynamic nature of some of these basing concepts, we exclude shared missile defenses from our estimates of resource requirements for the base archetypes.)

³³ The Air Force’s spare parts planning tools already have the capability to do such calculations.

Shared construction engineering. Construction equipment and materials are heavy and lift-intensive, so sharing these resources among operating locations would be useful in theory. In practice, however, sharing these resources would mean using them consecutively, so the feasibility of doing so would depend on conflict timelines. In CDO environments, each location might need construction teams to prepare it for operations. Engineering teams might need to build security features, temporary buildings, weapons caches, fuel handling and storage facilities, temporary aircraft shelters, and/or hardstands.³⁴ The demand for construction at an operating location would be tied to the overall Air Force strategy. A strategy that relies on mobility might reduce the demands for construction; in contrast, a strategy that aims to increase the resilience of each location would place higher demands on construction and engineering and lower demands on mobility. This is likely to be an area where host-nation support could expand the capacity of the Air Force to strengthen its locations, particularly if the Air Force could oversee the planning and implementation of construction at multiple locations.

Shared medical support. EMEDS is the Air Force's concept for providing medical support to forward locations. EMEDS is a modular, scalable set of deployable medical equipment and manpower. It dovetails with the aeromedical evacuation system to provide rapid treatment and movement of patients to higher levels of care.³⁵ EMEDS has a surgical focus and provides manpower and supplies that are catered to the mission of caring for traumatic injuries, sufficient to stabilize patients that need to be evacuated, or sufficient to return to duty those with less serious injuries.

Across a theater, medical planners make a determination as to which airfields will get an EMEDS package (or simply a small team), what size package they receive, and how theater evacuation and higher-level treatment will be handled. The determination of how much medical support goes to each location depends on many factors, and the uncertainty around how many casualties a location might experience is heightened in the high-threat environments envisioned by AB. The Air Force has not determined how it will reshape its medical support to best handle these types of threat and casualty environments. The Air Force might decide to put more-robust medical care forward to better handle casualty flows at operating locations. It also might create larger, more-robust capabilities to be shared by multiple operating locations, far enough away from any operating location to reduce the likelihood of attack on the facility but close enough to support several operating locations. The details of this decision calculus are complicated, but reducing the baseline amount of medical capability at forward locations would certainly pose risks.

³⁴ A *hardstand* is a paved area for parking aircraft or heavy vehicles.

³⁵ Don Snyder, Edward W. Chan, James J. Burks, Mahyar A. Amouzegar, and Adam C. Resnick, *How Should Air Force Expeditionary Medical Capabilities Be Expressed?* Santa Monica, Calif.: RAND Corporation, MG-785-AF, 2009.

In all of the areas described, sharing resources across bases presents risks; specifically, that the immediately available resources and capabilities will not suffice for an unforeseen or lower-probability situation. As with all AB concepts, the risks and rewards must be weighed. Some risks can be analyzed quantitatively, such as the sufficiency and responsiveness of maintenance and spare parts support. In other cases, where the uncertainties are not purely statistical (e.g., the likelihood of a ground-based attack), the trade-offs might be harder to intuit.

Integrated Basing in the Context of Base Archetypes

We now shift the focus of this chapter to the constructive tasks of (1) crafting standardized building blocks to represent base archetypes, (2) estimating the baseline ACS requirements of those building blocks, and (3) assembling those building blocks into integrated-basing networks.

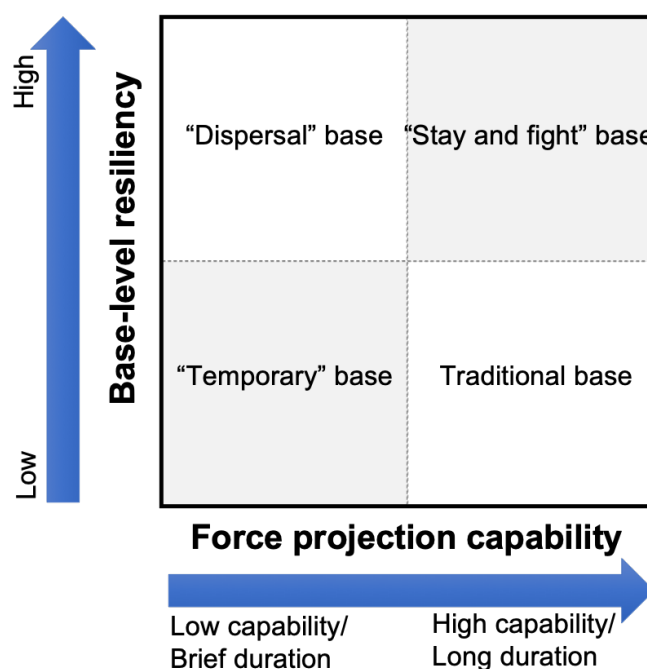
Crafting Standardized Building Blocks to Represent Base Archetypes

Integrated basing allows for great leeway for tailoring the designs of integrated bases to various operational objectives, threat environments, and logistical constraints. Ironically, this puts the Air Force in a tough spot as it tries to match its new operational concepts with their logistical support requirements for a profusion of base types. To help overcome this difficulty in the long term and promote a vibrant discussion between planners and logisticians in the short term, we present a framework for consolidating many types of integrated bases into four base archetypes.

In a CDO environment, some bases within the adversary's threat range could be used as short-term operating locations. Other bases farther from the threat could host large numbers of combat forces that require robust infrastructure support. Still other bases could combine different attributes of these forward and rearward bases. To reflect the spectrum of operational desirability and potential, the full set of possible base types could be compared and assessed along two dimensions of capability at the base: base-level resilience and force projection capability.³⁶ As depicted in Figure 4.3, the framework of base archetypes for AB locations captures both dimensions.

³⁶ Many factors contribute to the resilience of an operating location, including distance from a threat and theater-level or network-level assets that might offer protection or recovery capability. In this construct, we refer only to the capabilities—including infrastructure, equipment, and trained personnel—at a given location.

Figure 4.3. Framework for Characterizing Adaptive Basing Archetypes



The purpose of Figure 4.3 is to suggest not that there are only four types of bases, but rather that there is a wide tradespace of options across the two dimensions of resilience and capability. The following are the key distinctions among the four base archetypes in this framework:

- A traditional base is a robust base *outside* the adversary's threat range that is highly capable of long-term enduring operations at a high operations tempo. However, this base typically would not have high investments in base-level resilience, such as Airfield Damage Repair (ADR), aircraft shelters, or on-base dispersal of aircraft or fuel.
- A stay-and-fight base is a robust base *within* the adversary's threat range that is highly capable of both long-term enduring operations at a high operations tempo and surviving and recovering quickly after an attack, given the investments in base-level resilience.
- A dispersal base is capable of surviving an adversary attack but is designed to be used for only a brief period for low-intensity operations. In the context of AB, this base would recover aircraft that have fled from a stay-and-fight base to avoid enemy attack.³⁷
- A temporary use base is designed to conduct short-term low-intensity operations as part of AB maneuver concepts, such as FARP operations. The base would have minimal resilience measures and would be viewed as an acceptable loss if it were attacked after completion of its short-duration operations.

The consolidation of basing choices into four archetypes offers three key benefits: a common organizing principle, a common yardstick, and a common language. First, by differentiating

³⁷ The Joint community commonly uses the term *dispersal* to describe actions intended to enable forces to avoid attack. Joint Publication 1-02 defines *dispersal* as the "[r]elocation of forces for the purpose of increasing survivability" (DoD, 2016).

among the archetypes by their levels of resilience and capability, the framework emphasizes the strategic purpose of each archetype. For commanders, planners, and logisticians who would need to act quickly to design integrated-basing networks for dissimilar contingencies requiring different combinations of AB concepts, this common organizing principle of base archetypes and their strategic purposes could be a very helpful starting point. Second, the archetype framework implies a common yardstick of graduated ACS requirements for alternative AB concepts, from the integrated basing discussed in this chapter to the flexible operations and rapid scalability discussed in the next two chapters. Third, distilling the AB concepts and their ACS requirements into four base archetypes could advance the conversation between Air Force planners and logisticians by giving them a simple common language linked to their common goals.³⁸

Next, we examine each of the archetypes, or building blocks, in greater detail and tabulate the estimated personnel and equipment requirements for each archetype. We emphasize that the base archetypes and their baseline requirements, as presented in the tables in the next section, are not prescriptive, but descriptive. The estimated requirements are intended to facilitate the conversation between planners and logisticians about what resource requirements are implied by the AB concepts and about how those concepts might be implemented.

Estimating the Baseline Agile Combat Support Requirements of Archetypal Building Blocks

We used Lean-START to estimate the ACS mobility requirements of each archetypal base. We applied the planning assumptions shown in Table 4.1 to each archetype and assumed an austere location for each archetype. We then estimated the ACS personnel and equipment needed to bring each archetype to its prescribed levels of base resilience and force projection capability.

³⁸ Besides the two composite dimensions our framework uses, one also could vary such factors as the assumed quality of life, which would drive footprint requirements up or down. We view resilience and capability as the two core inputs, which in combination would drive different levels of quality of life. Lower quality of life probably would be assumed to keep the footprint light, and greater austerity could be tolerated by personnel for a short time. For a truly high-threat environment where attacks are anticipated, fewer quality of life-focused capabilities might be provided simply to reduce the personnel and equipment put in harm's way.

Table 4.1. Planning Assumptions for Determining the Resource Requirements of Base Archetypes

Assumption	Traditional	Stay and Fight	Dispersal	Temporary Use
Duration of operation	More than 30 days	More than 30 days	Less than seven days	Less than seven days
Combat operations intensity	18 PAA	18 PAA	Four combat turn areas	Four combat turn areas
Maintenance capability	Rearm, refuel, repair	Rearm, refuel, repair	Rearm, refuel	Refuel
Medical/QOL ^a	High	High	Medium	Low
ADR/EOD	None	Medium ADR	Small ADR	None
Airlift throughput (MOG)	Two	Two	One	One

NOTES: PAA = primary assigned aircraft. QOL = quality of life. EOD = explosive ordnance disposal. MOG = maximum on ground.

^a The Lean-START model computes BOS capabilities that equate to QOL based on duration of operations. In this case, shorter-duration operations have a low QOL (i.e., very austere conditions), while longer-duration operations have a more-robust capability associated with a fully established tent city.

The planning assumptions in Table 4.1 span six categories. First, we considered long-term operations for traditional and stay-and-fight bases to be those that last for more than 30 days. Such durations would be common for a traditional beddown and could be expected for a stay-and-fight base in a CDO environment. In contrast, the dispersal bases are intended for short-term operations, either in anticipation of an attack on an original location (e.g., a stay-and-fight base) or in response to an attack on an original location but before its ADR operations are complete. Forces could stay at a dispersal base until the threat of attack diminishes at the original location or until flying operations can resume at the original location.

Second, we sized the combat operations intensity for each archetype to its likely operations tempo. Third, we sized the maintenance capability depending on the maintenance functions (rearm, refuel, and repair) that likely would be conducted from each type of integrated base. For the temporary use base, for instance, we considered very short-term operations with only the capability to refuel. Fourth, we determined the medical/QOL category as high for traditional and stay-and-fight bases, medium for dispersal bases, and low for temporary use bases. Fifth, our requirements for ADR and EOD varied widely, from medium at stay-and-fight bases to none at traditional and temporary use bases. Fifth, we designated the maximum number of strategic airlift aircraft that each base archetype could load or unload on the ground at any one time, also known as the working MOG.

Given the six planning assumptions for the four archetypes, we estimated the ACS personnel and equipment requirements for each archetype. For ease of comparison, we divided the requirements into four ACS categories: sortie generation and repair, BOS, resilience, and airlift throughput. These categories appear in each of the next four tables.

Sortie generation and repair involves fuel storage and distribution (for all four archetypes), munitions storage and distribution (for three), and flightline and backshop maintenance (for two).

Fuel storage and distribution varied based on the number of aircraft supported, with stay-and-fight locations and traditional locations having a more-robust capability. BOS includes fire rescue, security forces, medical support, airfield lighting and arresting systems, and housekeeping sets (also adjusted to reflect an acceptable level of QOL based on duration of operations). Resilience includes ADR kits and EOD, but not active defense measures, such as missile defense systems. Airlift throughput includes materiel handling equipment (e.g., forklifts) to load or unload the designated MOG.

For each case, we highlight the amounts of equipment that would be good for prepositioning as war reserve materiel (WRM).³⁹ Because part of the challenge of establishing and operating networked bases would be moving personnel and equipment to, from, and among them, the data on possible WRM could be useful for weighing various movement options.

Traditional Base

A traditional basing beddown serves as our baseline for ACS requirements. The traditional base would be considered a safe haven, out of harm's way. In keeping with our first planning assumption from Table 4.1, the base would be sized to host several operational squadrons for an extended period (more than 30 days). Thus, this type of base would provide an enduring presence in the theater of operations.

Table 4.2 summarizes the personnel and equipment requirements associated with a traditional base, were it established at an austere location.⁴⁰ We highlight two important points from the table. First, the operational mission component, shown as sortie generation and repair, is relatively small in relation to the BOS and other equipment needed to establish an enduring presence at an austere location. The BOS requires 41 C-17s of airlift, whereas the operational unit requires just more than nine C-17s. Second, of the total lift requirement of 54 C-17s, more than half could be good candidates for prepositioning, which would still require some transportation assets to move them from the storage location in proximity to the beddown site but could reduce the strategic lift requirement to as few as 25 C-17s.

³⁹ We use the terms *WRM*, *prepositioning equipment*, and *prepositioned equipment* interchangeably. For this analysis, we deem the following categories to be good candidates for WRM: fuels operational readiness capability equipment (FORCE), base expeditionary airfield resources (BEAR), EMEDS, and all vehicles and nonvehicular rolling stock. This undoubtedly excludes some items which are currently in WRM, but provides a rough rule of thumb for our calculations.

⁴⁰ A traditional base could be any location, including an already established MOB. In this chapter, we focus on the resources required to establish new locations. Later, in Chapter Six, we estimate the resources required to shift capability among locations and the potential transportation requirements of doing so.

Table 4.2. Estimated Resource Requirements for a Traditional Base

Requirement	Personnel	Equipment Total (STONs)	WRM (STONs)	Non- WRM (STONs)	C-17 Total	C-17 Non-WRM
Sortie generation and repair	352	236	151	85	9	6
BOS	646	1,508	969	539	41	19
Resilience (ADR/EOD)	0	0	0	0	0	0
Airlift throughput (MOG)	8	160	160	0	4	0
Total	1,006	1,904	1,280	624	54	25

NOTES: The C-17 total represents the number of aircraft required to move all of the personnel and equipment.
STONs = short tons.

Stay-and-Fight Base

We now consider the resource and lift requirements for a highly resilient base that would be designed for high-intensity combat operations for an extended period. A stay-and-fight base would be fully operational, complete with a full complement of aircraft maintenance repair capabilities, and it would be able to bed down an aircraft squadron. The primary difference between the traditional base and the stay-and-fight base is that the latter would face the ongoing threat of enemy attack and would therefore require a substantial investment in resilience measures to enable it to recover quickly and return to combat operations after an attack.

We see in Table 4.3 that the airlift cost of resilience measures is quite large; in fact, it is greater than the airlift cost of all of the other measures combined. The total lift required for a traditional base was 54 C-17s. The resilience measures alone would add 32 C-17 equivalents. However, all of the ADR and EOD assets for base-level resilience could be good candidates for prepositioning. If all of those assets were prepositioned at or near the intended point of use, the remaining non-WRM airlift would increase by just one C-17 (from 25 to 26).

Table 4.3. Estimated Resource Requirements for a Stay-and-Fight Base

Requirement	Personnel	Equipment Total (STONs)	WRM (STONs)	Non- WRM (STONs)	C-17 Total	C-17 Non-WRM
Sortie generation and repair	352	236	151	85	9	6
BOS	882	1,543	969	574	44	20
Resilience (ADR/EOD)	0	1,425	1,425	0	32	0
Airlift throughput (MOG)	8	160	160	0	4	0
Total	1,242	3,364	2,705	659	89	26

NOTES: The C-17 total represents the number of aircraft required to move all of the personnel and equipment.

Dispersal Base

Many AB concepts call for reducing the aircraft densities at original beddown locations to reduce the value of each location to the adversary, minimize the impacts of attacks, and flush the aircraft to other locations from which they can continue to operate. These other bases are what we call *dispersal bases*.

A dispersal base might be capable of conducting combat operations for only brief periods when an attack is imminent or after an attack has occurred. A dispersal base typically has a smaller sortie generation and BOS footprint than a traditional or stay-and-fight base. The smaller footprint results from the lower capabilities in several functional areas. For example, a dispersal base would not have a full aircraft maintenance capability but would be sized to rearm and refuel aircraft only, with some limited on-equipment repair capability. Similarly, security forces might focus on flightline security as opposed to installation security, and firefighting might be scaled down to protect aircraft only, as opposed to both aircraft and base structures.

Consequently, dispersal bases would have significantly lower lift requirements than those needed for establishing traditional or stay-and-fight bases. As shown in Table 4.4, the total lift requirement for a dispersal base would be fewer than 22 C-17s, 12 of which would be needed to employ a small ADR/EOD package. Of the 22 total C-17–equivalent movements, only four would be required beyond a full investment in prepositioning WRM.

Table 4.4. Estimated Resource Requirements for a Dispersal Base

Requirement	Personnel	Equipment Total (STONs)	WRM (STONs)	Non-WRM (STONs)	C-17 Total	C-17 Non- WRM
Sortie generation and repair	74	58	43	15	2	1
BOS	221	178	155	23	6	3
Resilience (ADR/EOD)	0	507	507	0	12	0
Airlift throughput (MOG)	5	90	90	0	2	0
Total	300	833	795	38	22	4

NOTES: The C-17 total represents the number of aircraft required to move all of the personnel and equipment.

Temporary Use Base

The final base archetype is the temporary use base. A temporary use base would be intended for very short operations with no resilience measures. Such a base might be used for FARP operations lasting fewer than 24 hours or up to seven days. The absence of any resilience capability would be premised on the notion that if the base were destroyed by an attack, a combatant commander could shift operations elsewhere. A commander might employ temporary use bases if there were a sufficient inventory of remaining bases that could be used in the future.

Table 4.5 shows the ACS lift requirements to establish and operate a temporary use base. Relative to all other base types, the airlift costs would be minimal. If fully using prepositioned WRM, the airlift requirement would be reduced to a single C-17 flight.

Table 4.5. Estimated Resource Requirements for a Temporary Use Base

Requirement	Personnel	Equipment Total (STONs)	WRM (STONs)	Non-WRM (STONs)	C-17 Total	C-17 Non-WRM
Sortie generation and repair	53	28	25	3	1	1
BOS	90	112	112	0	4	0
Resilience (ADR/EOD)	0	0	0	0	0	0
Airlift throughput (MOG)	5	90	90	0	2	0
Total	148	230	227	3	7	1

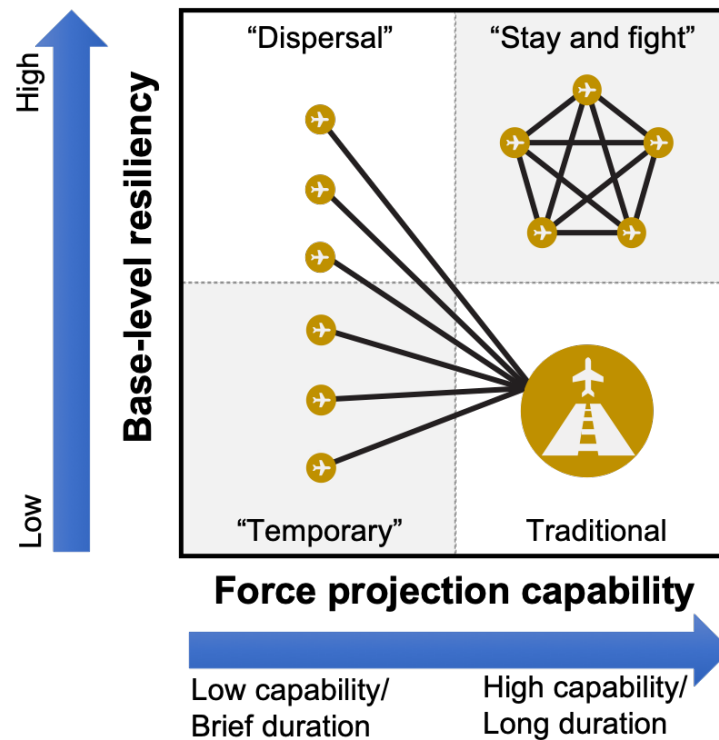
NOTES: The C-17 total represents the number of aircraft required to move all of the personnel and equipment.

Assembling the Building Blocks into Integrated-Basing Networks

We have presented the resource requirements for four base archetypes to identify the building blocks at hand. However, we presume that any integrated-basing network would contain some combination of bases from the different categories of archetypes. In fact, one purpose of placing the bases into four archetypal categories of resilience and capability is to assist combatant commanders in deciding which combinations of bases might make the most operational sense.

From just four shapes of archetypal building blocks, we can construct integrated-basing networks for a multitude of contingencies. Two examples appear in Figure 4.4. In the first case, an integrated-basing network links one traditional base (a standoff hub) with six dispersal and temporary use bases (the forward spokes). In the second case, five stay-and-fight bases form a tight, resilient, highly capable cluster. There are many other potential types of integrated-basing networks. For instance, there could be a forward stay-and-fight base ringed by a shell game of forward temporary use bases. Or there could be a rearward traditional base linked to a single forward stay-and-fight base. These decisions will depend on the CDO environments, the available aircraft, the resources, and a commander's risk tolerance. But the four archetypal building blocks can inform all of these decisions, at least as a first-order estimate of the resource requirements that planners and logisticians will need to address and then deliver.

Figure 4.4. Integrated Basing in the Context of Base Archetypes



So far, in this chapter, we have described several concepts of integrated basing, crafted four building blocks to represent archetypal bases, and assembled combinations of those building blocks into examples of integrated-basing networks. The estimated resource requirements for any network made from these building blocks could be added up easily, given the archetypal baselines provided in this chapter. Adding up those requirements also can suggest the obstacles to fulfilling them.

Obstacles to Fulfilling the Resource Requirements for Integrated Basing

The most-basic obstacle to fulfilling the resource requirements for integrated basing is that of limited resources. As described earlier, *all of the designs for integrated-basing networks, by definition, call for some type of dispersed basing*, which can require more resources per aircraft than required by traditional basing concepts. There is no single answer to the question of how many bases the Air Force can support; it depends on the basing design parameters chosen. But the estimated resource requirements for the four base archetypes suggest that the traditional and stay-and-fight bases would require the most resources and thus could encounter the greatest limitations. Past research also has shown some of the potential personnel limitations applicable to more-dispersed basing designs. Mills and colleagues assessed the capacity of the then-current ACS manpower force to support major combat operations with traditional deployments to bases

with about 1.5 squadrons as a rough force sizing and capacity assessment.⁴¹ They found that in several career fields, if following stated force package and skill level guidance, the total force could support only about two dozen locations simultaneously in a surge scenario. Since then, ACS manpower in most career fields has not grown.

Supplying the equipment to integrated-basing networks would present additional obstacles. The challenge with equipment is that the Air Force *already* faces shortfalls in its global inventory, let alone for expanding that inventory for any new, large-scale operating locations.⁴² WRM has been chronically underfunded against previously validated requirements, while the plans for integrated-basing networks would call for multiplying the number of new locations and thus the amount of total requirements. For instance, PACAF and USAFE both have been proposing large-scale expansions of their WRM equipment stocks, which suggests that they perceive even greater needs beyond their current requirements.⁴³

Even if resource limitations were not an issue, personnel limitations would be. Today, operational and logistics planners are the designers of basing configurations, but the current planners are not trained to design networks of bases that would enable operational adaptiveness throughout the course of a contingency. The many AB concepts that call for a variety of nontraditional network and integrated-basing designs also call for a variety of matching design skills.

Moreover, the operational benefits and risks of many designs of integrated-basing networks have not been assessed. RAND researchers have explored cluster basing, and ongoing research touches on other adaptive concepts, but more-thorough analyses are needed. As insights are gleaned into the most-effective and cost-effective network designs, planners can be trained in their uses and can then incorporate the designs into games, exercises, and, ultimately, operational planning.

⁴¹ Patrick Mills, John G. Drew, John A. Ausink, Daniel M. Romano, and Rachel Costello, *Balancing Agile Combat Support Manpower to Better Meet the Future Security Environment*, Santa Monica, Calif.: RAND Corporation, RR-337-AF, 2014.

⁴² WRM inventory data from the 635 Supply Chain Operations Wing show that, globally, the fill rate of WRM (on-hand divided by authorized) is about 50 to 70 percent, depending on the command, with the average being about 62 percent by dollar value. Data were provided on February 16, 2016. The authorized amounts, dating from early 2016, presumably are based on legacy requirements (i.e., not accounting for AB or other similar concepts).

⁴³ HQ USAFE and Air Force Africa and HQ PACAF are advocating to buy billions of dollars in new WRM, each under their own theater-unique deployable air base system (DABS) concepts. For USAFE, in fiscal year 2019, the Air Force plans on spending \$361 million for DABS equipment, \$206 million for storage facilities to house DABS, and a further \$48 million for production and deployment of enhancements to existing DABS infrastructure at undisclosed locations. See Valerie Insinna, “U.S. Air Force Tests ‘Base in a Box’ in Poland to Prep for Future Wars,” *Defense News*, August 26, 2018. These massive purchases alone suggest that the component commanders discern significant shortfalls in their current WRM inventories to meet their wartime responsibilities.

Next Steps

In the next two chapters, we discuss two critical maintenance and mobility functions, respectively, that combatant commanders could apply to the integrated-basing networks. In Chapter Five, we explore the possibilities for flexible operations and their additional resource requirements for aircraft operations and maintenance. In Chapter Six, we explore the possibilities for rapid scalability and its additional resource requirements for force mobility.

As in this chapter, Chapter Five begins by comparing traditional operations and maintenance approaches with those of flexible operations. We also will consider flexible operations in the context of base archetypes. We then discuss obstacles to fulfilling the resource requirements for flexible operations.

Likewise, Chapter Six begins by comparing traditional base buildup approaches with those of rapid scalability. We consider rapid scalability in the context of base archetypes and discuss obstacles to fulfilling the resource requirements for rapid scalability.

5. Resource Requirements for Flexible Operations

Flexible operations would be the key aviation operations and maintenance functions enabled by integrated-basing networks. In this chapter, we describe traditional approaches to aviation operations and maintenance, and we then note how flexible operations would work differently. (In short, flexible operations would decouple mission-generation maintenance from extended/low-frequency repair maintenance.) We discuss how flexible operations would support AB, how ACS could support flexible operations, and what these operations would look like in the context of the base archetypes. We conclude this chapter by outlining the obstacles to fulfilling the ACS requirements for flexible operations.

Traditional Aviation Operations and Maintenance

In this section, we outline how aviation and maintenance force packages are built, how they are deployed and employed, and how their combat power-projection capability is estimated.

How Aviation Operations and Maintenance Force Packages Are Built Today

As noted, the Air Force packages and deploys predesigned capabilities defined as UTCs. The current Air Force deployment approach is for aviation units to deploy with their UTCs (known as *3-series UTCs*) for aircraft, aircrews, life support and flight surgeon staff, and other minimal aviation squadron gear and staff.⁴⁴ In addition, each aviation UTC has an associated maintenance UTC or set of UTCs (from the HF series); maintenance UTCs are used for turning the aircraft (or preparing the aircraft to launch a sortie) and for repairing the aircraft when broken. The core capabilities of maintenance UTCs are sortie generation, aircraft repair, and weapons loading. There also are UTCs (from the HG series) for assembling the munitions. Table 5.1 shows these cascading UTC affiliations for F-16s and F-22s.

⁴⁴ Aviation units are coded as 3-series UTCs (e.g., 3FXXX is a generic UTC for an aviation fighter aircraft).

Table 5.1. Aviation, Maintenance, and Munition Unit Type Code Affiliations for Selected Fighter Aircraft

Weapon System	Aviation UTC	Maintenance UTC	Munition UTC
F-16	3FKS1	HFKS1	HGKS1
F-16	3FKS2	HFKS2	HGKS2
F-16	3FKS3	HFKS3	HGKS3
F-22	3FBE1/3FBP1	HFBE1/HFBP1	HGBE1/HGBP1
F-22	3FBE2/3FBP2	HFBE2/HFBP2	HGBE2/HGBP2
F-22	3FBE3/3FBP3	HFBE3/HFBP3	HGBE3/HGBP3
F-22	3FBE4/3FBP4	HFBE4/HFBP4	HGBE4/HGBP4

The aviation and maintenance pairings are designed to deliver some combat capability described in the MISCAP statement. The MISCAP statement contains a narrative about what generally is contained in the UTCs, what environments they can operate in, and, in some cases, the number of sorties each aircraft can be expected to fly in a 24-hour period. The latter is referred to as the sortie rate.⁴⁵ For example, the following is the MISCAP statement for a UTC 3FKS1 for deploying the first 12 F-16s into a forward operating location:⁴⁶

Supported by HFKS1, HGKS1, HEKS1, HEPRT/HEGEE (based on type [of] engine installed), HFAN8, HFAN3 or HFAN4; HFBZP and HFAFE. Requires weapon system video support. Requires FFLGE for medical equip support. Provides [independent] 12 ship [fighter support] for contingencies and/or general war. Sortie duration and expenditure rates are [in accordance with] WMP-5. Can operate up to 30 days at a [forward operating base] flying WMP-5 rates based on [mobility readiness spares package]. Employs conventional munitions day/night (including [precision-guided munitions] listed on [unit committed munitions list]) in the [surface to air, air interdiction, offensive counter-air strike, suppression of enemy air defenses, destruction of enemy air defenses, offensive counter-air attack, and defensive counter-air] roles. Includes [commander, administration, operations data management], aircrews, aircrew flight equipment (AFE), [intelligence, flight medicine, and weather]. For additional [intelligence] requirements task PFXXX UTC. Requires RFB-series UTC for personnelist support. [Aircraft] deploy [with electronic countermeasure] and [harm targeting system] pods. Tasked [commander] has authority to substitute equivalent skill-level [Air Force specialty codes]. [Air Reserve Component] units may substitute grade requirements two grades up or one grade down. Use deployment echelon codes for planning and execution. To increase [primary mission aircraft inventory] to 18, UTC 3FKS2 must be tasked. To increase [primary mission aircraft inventory] to 24, UTCs 3FKS2/3 must be tasked.

The MISCAP statement above immediately identifies the associated UTCs that must be deployed with the 3FKS1 aircraft to provide it with full maintenance support (HFKS1),

⁴⁵ U.S. Air Force, *War and Mobilization Plan*, Volume 5 (WMP-5), *Basic Planning Factors and Data*, Washington, D.C., 2011, Not available to the general public.

⁴⁶ U.S. Air Force, 2016a.

munitions support (HGKS1), and intelligence support (HEKS1) at the beddown location. The following is the MISCAP statement for HFKS1, which is required to be deployed with 3FKS1 to provide maintenance capability:⁴⁷

Supports UTC 3FKS1. Provides initial maintenance support and an independent [mobility readiness spares package] for 12 F-16 [block] 50 aircraft. Capable of bare base operations. Requires vehicle UTC UFM52 (MB-4) to be tasked at one per 6 aircraft and a maximum of two (2) UFMEC (Bobtail) or equivalent if not available at deployed location. UTC JFBFP will be tasked for [mobility readiness spares package] management. Supporting [company commander] has authority to substitute [Air Force specialty codes] without diminishing [forward air control] capability. Use deployment echelon codes for planning and execution. [Office of primary responsibility]: HQ ACC/A4RFX, [defense switched network] 574-2786. Reviewed [December] 15.

We quote these two MISCAP statements in their entirety to offer a sense of how UTCs, along with their dependencies, are defined and layered to provide a combat-projection capability. We also want to highlight the use of the deployment echelon codes in the MISCAP statements.

Deployment echelons identify subcapabilities provided by different functional communities. Within maintenance UTCs, there are deployment echelons coded E, S1–S3, and T1–T5. The E-series deployment echelon, called the Enroute Support Team (EST), is a small package that will receive an aircraft if it stops at an intermediate location on the way to its final destination. The EST recovers the aircraft at the intermediate location, turns the aircraft, and launches it to its destination. An EST is an aircraft-generation capability with very limited maintenance. The S-series deployment echelon is called the Initial Support Element; according to Air Force policy, this element should provide everything needed to recover an aircraft at its deployed location, turn the aircraft, and launch its first combat sortie. In other words, the S-series deployment echelon ensures that a deployed aircraft will reach initial operating capability (IOC).⁴⁸ The T-series deployment echelon provides a much more extensive maintenance capability, which repairs parts that have been removed from an aircraft and performs scheduled maintenance on items that come due. There are sub-subcapabilities embedded within the S-series and T-series echelons. For instance, the S1 echelon, referred to as the advanced echelon (ADVON) team, is a small group of personnel with very limited tools and equipment who are responsible for being first on the ground at the beddown site and for planning the arrival of the remainder of the Initial Support Element.

We explain the current structure of UTCs and the use of deployment echelon codes in such detail to impart an appreciation of the meticulous planning that has gone into creating these force

⁴⁷ U.S. Air Force, 2016a.

⁴⁸ See U.S. Air Force Instruction 10-401 for a more-detailed description of deployment echelon codes and how they are used for different functional communities in constructing UTCs (U.S. Air Force Instruction 10-401, *Air Force Operations Planning and Execution*, Washington, D.C., incorporating through change 4, March 13, 2012).

deployment packages for use during contingencies. This inheritance can serve as the foundation for changes that might be required to execute some AB maneuver concepts.

How Aviation Operations and Maintenance Force Packages Deploy Today

Air Force planners usually will select operations, maintenance, and munitions personnel and equipment from the same wing when sourcing a deployment capability. This method typically is preferred because the aircrews, maintenance crews, and munitions personnel from the same wing know one another and have an established level of trust; the maintenance crews know the nuances and history of each aircraft in the wing; and unit integrity is considered to be important in combat.

Table 5.2 shows the standard sizes of the force packages (in C-17 equivalents) for the F-16 UTCs highlighted in Table 5.1. Moving a lead package of 12 F-16 aircraft and their associated maintenance and munitions assets ordinarily requires the equivalent of eight C-17 aircraft. This package includes the capability to generate combat sorties and the capability to conduct a full spectrum of maintenance repair operations: both scheduled and unscheduled flightline and backshop repairs.

Table 5.2. Standard Movement Requirements for Fighter Aircraft Unit Type Codes

Weapon System	UTC Packages	Personnel	STONs	Total C-17 Loads
12 PAA F-16 lead	3FKS1, HFKS1, and HGKS1	297	223	8
Six PAA F-16 follow	3FKS2, HFKS2, and HGKS2	104	69	3
Six PAA F-16 follow	3FKS3, HFKS3, and HGKS3	57	49	2
Full 24 PAA F-16 unit		458	341	13

SOURCE: The UTCs and their associated weights and personnel were drawn from the Logistics Force Packaging Subsystem (LOGFOR) in March 2016.

For a typical deployment—in which a full squadron of 24 F-16 aircraft from the same wing would bed down at a single new location—the aviation operations, maintenance, and munitions organizations would deploy a total of 458 personnel and 341 STONs of cargo, requiring a total of 13 C-17 equivalents to complete the move. That collection of resources would be capable of flying a standard WMP-5 sortie rate over the course of 30 days.

There are two caveats to this discussion of the linked aviation operations, maintenance, and munitions capabilities that normally would deploy together today. First, UTCs represent, by definition, the types of predefined packages of personnel and equipment required for a specified capability. When responding to a contingency, combatant command planners still need to specify the quantities of those capabilities required for a particular course of action. The combatant

command planners then can assign Air Force units to provide those designated quantities of UTCs. Second, although the philosophy of unit integrity has carried forward into experiments of alternative AB maneuver concepts, such as Rapid Raptor and Rapid-X, the sizes of the experimental force packages have been substantially reduced to allow for quicker movements.

How Combat Power-Projection Capability Is Estimated Today

To estimate the power-projection capability of aviation operations, the Air Force calculates sortie rates. The sortie rate is the number of sorties (or missions) that a given aircraft can fly per day. The WMP-5 provides sortie rate-planning factors used by combatant command planning staffs.⁴⁹ These factors incorporate inputs from the combatant commands, such as sortie duration based on theater geography. For each theater, the model that calculates the WMP-5 sortie rates produces a breakdown of rates by phase of operation for each weapon system.

A sortie rate accounts for several factors that influence sortie generation directly or indirectly. The first direct factor is sortie duration. In essence, if an aircraft could continuously fly two-hour sorties back to back with an instantaneous turn, the sortie rate for the aircraft would be 12 (24 hours / 2-hour sortie duration = 12 sorties per day). In Table 5.3, we break down the direct and indirect factors that influence how many sorties an aircraft can fly in a 24-hour period. The Air Force uses these factors—and the values for these factors (some of which are driven by policy, others by historical trends)—to estimate the sortie rates and thus the combat power-projection capability.

⁴⁹ See U.S. Air Force, 2011, Appendix A, Not available to the general public, for more details.

Table 5.3. Direct and Indirect Factors Influencing Sortie Generation

Direct Factors	Indirect Factors
Sortie duration	Aborts Ground Air
Aircraft taxi times	Aircrew limitations
Preflight	Rest
Postflight	Flying hour limitations
	Maximum sorties
Aircraft turn times	Aircrew availability
Postflight inspection	Crew ratio
Rearm	Scheduling/planning day
Refuel	Duty not including flying (DNIF)
Preflight inspection	
	Operations
	Duty day
	Briefing times
	Flight size
	Flying window
	Aircraft unscheduled maintenance
	Aircraft periodic (scheduled) maintenance
	Maintenance crews/turn limitations

SOURCE: U.S. Air Force, 2011, p. A-1, Not available to the general public.

The direct and indirect sortie-generation factors in Table 5.3 also drive the personnel and equipment requirements for the UTC force packages listed in Tables 5.1 and 5.2. Those UTC requirements could include, for example, the maintenance personnel and equipment needed to operate four turn areas on the flight line or the maintenance personnel, tool kits, and spare parts needed to perform periodic maintenance.⁵⁰

Therefore, when pondering any AB maneuver concepts that hinge on speed and resources, it will be important for Air Force planners to consider the maintenance capabilities embedded within the maintenance UTCs. These UTCs, along with their associated deployment echelons, generally are structured around two capabilities tied to the sortie rate: the capability to turn aircraft and generate sorties (i.e., the direct factors influencing sortie generation) and the capability to repair aircraft (i.e., the indirect factors influencing sortie generation). There is some overlap of resources across the two capabilities; for instance, a maintainer who is used for generating sorties also could perform some basic repair activities.⁵¹ However, the overall UTC

⁵⁰ A *turn area* is a location on the flight line where aircraft are prepared for their mission. Activities at the turn area include postflight inspection, weapons loading, refueling, and preflight inspection. These are shown in Table 5.3 under “direct factors.” We focus on the resources required for four combat turn areas because that is how many would typically be established to support six to 12 aircraft at a location to achieve the WMP-5 sortie rates. Four turn areas allow the Air Force to generate and launch four aircraft at a time, which is the typical aircraft mission package.

⁵¹ This topic has been a subject of prior RAND research. See Ronald G. McGarvey, Manuel J. Carrillo, Douglas C. Cato, Jr., John G. Drew, Thomas Lang, Kristin F. Lynch, Amy L. Maletic, Hugh G. Massey, James M. Masters,

and resource distinctions between turning and repairing aircraft likely will imply key AB trade-offs.

How Flexible Operations Would Differ from Traditional Operations

How Aviation Operations and Maintenance Force Packages Might Be Built

Although today's force packages are built with flightline and backshop together in maintenance UTCs, these AB maneuver concepts could require the Air Force to decouple flightline maintenance from backshop maintenance, specifically by placing the flightline maintenance capabilities at some of the integrated-basing locations. This decoupling of flightline maintenance would incur additional manpower and equipment costs because some mission-generation maintainers perform repair activities when not actively generating aircraft.⁵² However, the maneuver concepts would not all demand a full complement of flightline maintenance capabilities at each site.

There are two levels of flexible operations that would support AB from integrated-basing networks within a CDO environment. The first and most fundamental is simply the capability to recover aircraft, refuel them, and send them on their way. This capability often is practiced at bases in CONUS when aircraft fly cross-country and need on-ground refueling. This practice is known as *TA servicing*.⁵³ The second level of flexible operations that would be enabled by integrated-basing networks is the capability to recover aircraft after a combat sortie, refuel the aircraft, reload munitions, and then launch another combat sortie. This is the capability we have called *launch and recover* (L&R).⁵⁴

Beyond those somewhat generic categories of aircraft servicing capability, these new AB-driven force packages also could vary by several additional factors, adding granularity to force packages. Such factors could include

- **duration:** Staffing and supplies for traditional combat aircraft maintenance UTCs are designed for 30 days of operations, at which time additional support is required or sustainment begins. Some AB concepts could require UTCs be developed to operate at a

Raymond A. Pyles, Ricardo Sanchez, Jerry M. Sollinger, Brent Thomas, Robert S. Tripp, and Ben D. Van Roo, *Analysis of the Air Force Logistics Enterprise: Evaluation of Global Repair Network Options for Supporting the F-16 and KC-135*, Santa Monica, Calif.: RAND Corporation, MG-872-AF, 2009.

⁵² McGarvey et al., 2009, analyzed two fleets—F-16 and KC-135—and found that more than one-third of the 31 maintenance work centers had workload and manpower shared between flightline sortie generation and backshop repair. See McGarvey et al., 2009, p. 31, for example.

⁵³ One good example of a TA capability in the Air Force is at Tinker Air Force Base, Oklahoma, home to one of the Air Force's three Air Logistics Complexes, which include major aircraft and engine overhaul operations. At Tinker, a team of 20 contractor personnel is capable of servicing virtually every aircraft type in the Air Force inventory.

⁵⁴ Earlier in this report, we referred to FARPs as locations from which one might conduct some AB operations. FARPs are the *locations* that are established, and L&R is the specific *maintenance capability* deployed to those locations.

higher intensity for a much shorter duration (less than 24 hours) conducting only mission generation, in which case, spare parts would not be needed and the staffing composition might include a different skill mix.

- **package size:** The 30-day UTC packages described earlier typically are designed and sized to perform a mix of maintenance actions (e.g., aircraft mission generation, on-aircraft repair, off-aircraft repair) on 12 to 24 aircraft. In most cases, personnel performing aircraft mission generation at scheduled intervals (e.g., three launches per 24 hours) also will perform on-aircraft repair activities when not launching aircraft. The flexible operations concept would limit the package to just the personnel and equipment needed to conduct aircraft mission-generation activities nonstop over 24 hours.
- **munition type:** for example, air-to-air versus air-to-ground, the latter of which requires significantly more personnel and equipment.
- **multiple MDSs:** Maintenance personnel generally are certified on the weapon system owned by their current unit. To support AB operations, maintainers would need to be concurrently qualified and certified to work on different MDSs.

Whereas the internal structure of today's maintenance UTCs (including deployment echelons) incorporates some modularity that is appropriate for AB concepts (e.g., the EST and ADVON teams), more AB-driven force packages likely would be built on a wider variety of combinations of the factors listed above, giving planners more options to tailor packages to various AB integrated-basing structures.

How Aviation Operations and Maintenance Force Packages Might Deploy

Given that the input parameters driving the design of force packages would change to support AB, what would those force packages look like? In Table 5.4, we show the estimated ACS equipment footprint, measured in STONs, and the ACS personnel requirement associated with each level of flexible operations for a lead squadron of 12 F-16s. For TA and L&R, we estimated the ACS requirements for performing four simultaneous turns (establishing and operating four turn areas on the flight line). The size of those packages is significantly smaller than that of a traditional package for 12 F-16s deploying for a 30-day engagement, which is shown in the third row of the table as traditional maintenance.

Table 5.4. Estimated Agile Combat Support Requirements for Two Levels of Flexible Operations for 12 F-16s, and a Comparison with Traditional Operations

Maintenance Capability	STONs	Personnel	C-17 Equivalents
TA (refuel only)	12	30	<1
L&R (refuel and rearm)	40	61	2
Traditional maintenance (refuel, rearm, and repair)	154	272	7

This case illustrates the deployment implications (for a single location) of departing from the traditional WMP-5 sortie rates for the 30-day force packages of today to a more-granular view of mission-generation capability.

One challenge this case raises is that the CAF must establish not a collection of mostly independent traditional bases, but a rationalized network of bases with varying levels of mission-generation and repair capabilities, calibrated for the operational demands and threat environments that it will face. Fortunately, the MAF already operates such a network with a global enroute support network; this could serve as a template for the CAF to partially emulate.

How Combat Power-Projection Capability Might Be Estimated

If the TA and FARP resources in Table 5.4 remain attached to a unit of 12 aircraft flying at a rate of 1.5 sorties per day, they can generate a total of 18 sorties per day. However, these same resources, if available to provide TA or FARP services to any aircraft that land at their base, can produce many more sorties per day when not limited by the number of available aircraft.⁵⁵ The latter case is what is envisioned for the AB maneuver concepts.

We look back at Table 5.3 to explain the difference. When the sortie generation is limited to a unit's 12 aircraft, the number of sorties that can be flown tends to be limited by the availability of those aircraft to be prepared and launched (i.e., turned) to fly a mission. Table 5.3 points to some limitations rendering aircraft unavailable, such as undergoing scheduled or unscheduled maintenance or flying the mission. During those times, the flightline maintenance resources are idle because of limitations on aircraft available to be generated.

One way capability for the CAF might be estimated is by the throughput capacity of each location. Likewise, a networkwide sortie potential might be estimated, subject to how those bases are used. For traditional operations, the WMP-5 would provide, for each phase, MDS and sortie duration and an expected sortie rate. For the more-complex and more-challenging flexible operations concepts, new rates of some kind must be estimated. It is broadly acknowledged that the current WMP-5, which is now seven years old, needs to be reworked.⁵⁶ This is a topic of much discussion and attention by the air staff, but establishing metrics (and their appropriate expected values) specific to AB will require some time as AB concepts are fleshed out.

⁵⁵ Theoretically, the upper limit on the aircraft serviced per day (i.e., sorties cycling through) is 48 combat sorties per day, using the sortie duration factor of two hours for each of four integrated combat turn areas. That might hold true for the runway itself and the equipment, but the personnel might need to be increased to accommodate work-rest cycles for a 24-hour period. However, this force package itself could not sustain combat power over any period of time, given its lack of repair capability.

⁵⁶ Discussions with PACAF/A5 personnel on November 8, 2016; with Logistics, Engineering, and Force Protection Directorate (AF/A4) and Strategic Plans and Programs Directorate (AF/A5) personnel on November 18, 2016, and December 22, 2016; with HQ Air Force Installation and Mission Support Center personnel on February 8, 2017; with AF/A5 personnel on November 27, 2018; and with AF/A4 personnel on January 7, 2019.

How Flexible Operations Would Support Adaptive Basing

The Air Force might want to use flexible operations to maneuver forces for any number of reasons. It might want to limit the amount of time aircraft sit on the ground within range of enemy missiles. It might want to move aircraft so they could generate sorties from different bases to confuse enemy targeting. Given advance warning of an attack, the aircraft might be flushed from a base and dispersed to other locations to regroup. To maintain MISCAP after an attack, the aircraft might be directed to return to a different location from where they were initially launched. Many of these operations would depend on the Air Force's ability to maneuver the aircraft faster than the enemy could find, target, and attack them.

Creating the Agile Combat Support Competency to Support Flexible Operations

To support flexible operations, the ACS community could build lean maintenance force packages for sortie generation. Different levels of packages could be built for different levels of flexible operations (i.e., refuel only; refuel and rearm; and refuel, rearm, and repair under fire). These packages would build on the AB notion that bases are fighting positions, not sanctuaries. Although permanent beddown sites with large maintenance and BOS footprints would be needed in any scenario, not every site would need to be permanent. Lean aircraft mission-generation maintenance packages could be routinely dispatched to open fighting positions for short periods.

Under the current deployment concept of maintaining the unit integrity of aircrews and maintenance crews, there are limits to the number of sites that a unit can support. There are limited resources available, and there is limited time to reposition the resources at multiple sites.

The Air Force could mitigate these limitations in two ways. One would be to invest in additional aircraft mission-generation maintenance and repair maintenance elements per squadron to allow these full-service maintenance squadrons to open multiple sites dedicated to the same unit so that its aircraft could return to different locations from wherever they launched but still be fully maintained by crews from the same unit. Such an investment in unit integrity and force presentation could be a subject of future research.

The other way, as suggested earlier, would be to decouple the aircraft mission-generation maintenance and maintenance repair activities and to make the aircraft mission-generation maintainers across the integrated-basing networks capable of servicing the same type of aircraft from any unit. For example, an aircraft from Wing X could be launched by the maintenance personnel from Wing X to conduct a combat mission, but the aircraft could return to a location staffed by maintenance personnel from Wing Y, who would perform a combat turn and prepare the aircraft for its next combat mission. This flexibility would enable maneuver operations without requiring either additional maintenance resources for Wing X or the relocation of those

resources. This concept could be extended further by cross-training the maintenance personnel to be certified in servicing multiple types of aircraft.

Operating in this manner is not without risks. Moving regularly among different temporary operating locations, staffed with only the maintenance personnel needed for aircraft mission generation, severely limits the ability to repair aircraft that divert in need of repair or break on the ramp while being regenerated. Mitigating this risk would need to be considered when planning for flexible operations.⁵⁷

Because TA and L&R capabilities require so much less personnel and equipment than the full repair capability, they can be established much more cheaply. Cross-training makes the personnel more affordable, but difficult trade-offs remain to establish cost-effective networks of bases with regard to spares, equipment, and personnel to put at each location, given the potential operational benefits. Again, further research is needed.

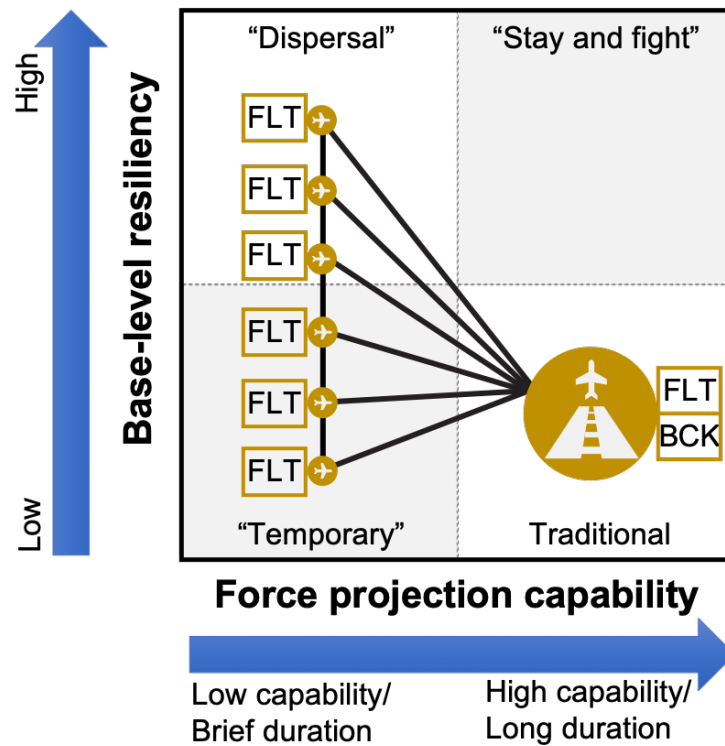
The value of executing flexible operations in the context of AB is to reduce the time on the ground at any location and thereby limit exposure to enemy attacks. Limiting the time on the ground requires the Air Force to renew its approach to performing mission-generation activities. Typically, activities accomplished during a combat turn include refueling the aircraft and rearming the aircraft with munitions. Today, these activities typically are accomplished in sequential order. In the past, the Air Force exercised the practice of conducting these activities concurrently under a concept called an *integrated combat turn* (ICT). Developing TTPs for ICTs and reestablishing them as a common practice can further increase the value of flexible operations as an element of AB.

Flexible Operations in the Context of Base Archetypes

Recall that the archetypal quadrants from Chapter Four (in Figures 4.3 and 4.4) compare AB locations along two dimensions: base-level resilience and force-projection capability. Although not shown in Figure 5.1 for the sake of simplicity, the flexible operations discussed in this chapter—for TA, L&R, and repair under fire—would increase the force-projection capabilities by varying amounts at the temporary use and dispersal bases by adding flightline maintenance to them. Traditional bases would still provide both flightline and backshop maintenance, and stay-and-fight bases would provide both as well, contributing to the superior force-projection capability of both of these base archetypes. However, Figure 5.1 emphasizes the two distinctive benefits for a combatant commander of providing flightline maintenance at the six other bases: the flexibility for aircraft to receive flightline maintenance from any of the spokes and from the hub and thus the increased flexibility to operate from any of the spokes without having to return to the hub.

⁵⁷ The MAF does this today by deploying MRTs to fix aircraft requiring repair that are stranded at a location without sufficient or appropriate maintenance personnel.

Figure 5.1. Flexible Operations in the Context of Base Archetypes



NOTES: FLT = Flightline maintenance. BCK = Backshop maintenance.

For visual simplicity, Figure 5.1 is less complex than the anticipated reality: An aircraft from any of the six spokes in the figure could fly to all five of the other spokes to receive flightline maintenance. Thus, there would be 15 alternate routes connecting each of the spokes rather than just the five linear, vertical routes shown in the figure. (The five vertical links are meant to represent the tighter overall operational integration that would be made possible by the ability of aircraft to fly directly between any two of the six spokes for flightline maintenance.)

Obstacles to Fulfilling the Agile Combat Support Requirements for Flexible Operations

We see the following three categories of obstacles to establishing the ACS competency for flexible operations:

- combat team culture
- training
- UTC structure.

Combat Team Culture

The notion of flightline maintenance teams being decoupled from their aircrews challenges the prevailing combat team culture in the Air Force. Unit integrity is important to combat units. Fighter pilots are used to walking out of an aircraft and seeing their crew chief standing nearby. The team culture is so ingrained that, at one point, it was commonplace for the Air Force to list both the pilot's name and the crew chief's name on the side of their shared fighter jet.⁵⁸

On the other hand, the *airlift* team culture is very different from the *combat* team culture. In general, the Air Force's strategic lift aircraft depart a base with minimal maintenance and servicing crew organic to the aircraft. Airlift aircraft arrive at a location and receive fuel from the arrival base, and personnel there turn the aircraft.⁵⁹ If an aircraft requires more-intensive repair, an MRT is dispatched to make the repairs. It is possible that the MRT will not be from the airlift crew's home station but, instead, will be from a like-MDS unit in closer proximity. Thus, flexible operations would take the aircraft-generation and maintenance repair practices used routinely in the MAF today and apply them to the CAF.

Training

Although today's TA crews in the airlift community can service a wide variety of aircraft types, there are no comparably versatile crews for FARP and repair activities for combat forces. Aircraft maintenance personnel undergo lengthy training to be certified on a specific aircraft type, and weapons loaders undergo training on the combination of the aircraft and munitions. Restricting maintenance personnel to their unit-assigned MDS would require expanding the number of required additional maintenance personnel and weapons loaders to conduct flexible operations, with each flexible operations location needing personnel certified in servicing each type of combat aircraft (e.g., F-15s, F-16s, F-22s).

However, by certifying maintenance personnel in multiple weapon systems and munitions types, the Air Force could expand the capability of maneuver bases without necessarily increasing the manpower requirements. There was insufficient time during this project to examine both the benefit and cost or difficulty of certifying maintenance personnel in multiple weapon systems; however, it is an area that could be analyzed further as the Air Force moves forward with implementing alternative AB concepts.⁶⁰

⁵⁸ U.S. Air Force Instruction 21-105, *Fabrication Program*, Washington, D.C., April 21, 2016, p. 21.

⁵⁹ In fact, AMC manages an entire global enroute support network of locations with varying levels of capability to service transiting aircraft.

⁶⁰ Several efforts in the Air Force have touched on this to different degrees. One example was the 2017 Installation and Mission Support Weapons and Tactics (I-WEPTAC) conference.

Unit Type Code Structure

As explained previously, the UTC structure is built on the premise that operations and maintenance personnel from a single base will deploy to a single forward operating location and operate from there for the duration of a conflict. At that location, the personnel will produce some number of sorties over a 24-hour period based on the availability of aircraft to fly and on the amount of time it takes to taxi the aircraft, refuel and rearm it, and fly the planned mission.

This UTC structure would impose three limitations on flexible operations. First, yoking maintenance personnel to a fixed number of aircraft does not maximize the production capacity of aircraft mission-generation resources. Recall from Table 5.3 that several indirect factors drive sortie rates for a standard 18–24 aircraft package (e.g., aircrew availability, mission brief and debrief activities, aircraft availability as a result of conducting a mission or unscheduled maintenance). We estimate that, based on current combat aircraft maintenance UTCs, the capability of resources that would be earmarked for establishing four turn areas and generating combat sorties would exceed the availability of aircrew and aircraft that could be turned.⁶¹

Second, the current UTC structure does not differentiate among subelements of personnel and equipment according to the capabilities needed for flexible operations—those capabilities being TA (refuel only) and FARP/L&R (refuel and rearm). Given that either of the two tiers of capabilities might be required at any number of integrated bases, operating in an interdependent fashion requires preidentifying subelements of personnel and equipment that are capable of providing those tiered capabilities.

Third, the standard (large) sizes of today’s maintenance packages would be ill-suited to rapid redeployments from forward operating locations or to repeated relocations in and out of different bases to avoid or complicate enemy targeting.

These categories of obstacles—combat team culture, training, and UTC structure—would need to be addressed by the Air Force as it contemplates the resource requirements for flexible operations, specifically for distributed flightline maintenance. Future analysis could examine the degree to which the current manpower and equipment levels, as driven by the current UTCs, could or could not support the implementation of flexible operations.

⁶¹ We were not able to make similar estimates for the on-equipment and off-equipment maintenance repair capabilities. That remains a potential topic for future study.

6. Resource Requirements for Rapid Scalability

Rapid scalability and integrated basing are mutually reinforcing: Integrated basing enables rapid scalability when it provides a network of well-configured resources that can be used to rapidly scale up and down capabilities. Rapid scalability, in turn, provides a responsive integrated-basing network, which enables operational commanders to tailor base capabilities to suit changing objectives and threat environments.

In this chapter, we first describe traditional approaches to base buildups and how rapid scalability would be different. We discuss how rapid scalability would support AB and how to build the ACS competency to perform rapid scalability. We then consider rapid scalability in the context of the base archetypes. We conclude this chapter by discussing the obstacles to fulfilling the resource requirements for rapid scalability.

Traditional Approaches to Base Buildups

Traditional base planning starts with a concept about the forces that will reside at a forward base, the type and level of operations to be conducted from that base, and the full complement of support resources needed to build up the base. The traditional deployment process aims to deliver personnel and equipment on time, according to a preplanned schedule, to achieve a sustainable end-state capability. The process has built-in buffers and delays to allow for maximum utilization of scarce lift assets. The prioritization and sequencing of the elements of a traditional deployment favor the incremental buildup of a base to support its initial capacity and then its full capacity, ultimately resulting in the kind of sustained, robust, and independent base described in the section on “Traditional Basing Approaches” in Chapter Four. The last three major U.S. combat operations show a strong relationship between the size of a deployment and the time to complete it.⁶²

Traditional base buildups are steady and deliberate. The deployments generally move from home-station locations through theater transportation hubs to singular forward operating locations from which long-term operations are meant to be conducted.⁶³

The operational and logistics planners at home-station locations manage the traditional deployment process on their end, usually with help from augmentees, because the deployment

⁶² Mills et al., 2016, Not available to the general public.

⁶³ U.S. Air Force Chief of Staff General David Goldfein stated that “Over time, we’ve migrated away from the original design of the expeditionary Air Force from a force organized to deploy forward, establish new bases, defend those bases . . . to a force that often cannibalizes itself to send forward sometimes individual airmen from every wing of the Air Force to join a mature campaign with established leadership, basing, and C2 infrastructure” (Joseph Trevithick, “USAF Wants Units to Rapidly Build and Fly from New Bases in the Middle of a Future War,” *The Drive*, September 19, 2018).

process can be very manually intensive. Phase 1 exercises—those in which airmen at home-station locations practice deployment skills—do exist, but according to conversations with various Air Force SMEs, these exercises are no longer as frequent as they were before the combined stresses of OEF and OIF began 15 years ago.⁶⁴ Before that time, the Phase 1 deployment processes and skills were exercised quarterly; this is no longer the case.⁶⁵ This means that today's deployment capabilities are dependent on less experienced airmen functioning within a slower, rotation-focused deployment machine.

How Rapid Scalability Would Differ from Traditional Base Buildups

The key characteristics that would differentiate rapid scalability from traditional base buildups are all variations on a theme: speed, agility, and responsiveness. Those attributes imply an ability in the logistics system to quickly translate a command into action, make lift resources available, wind down operations in one location and shift them to another (or keep the operations going in one location while starting to redeploy to another location), generate mass in the airlift assets that is sufficient for the potential task of redeployment, and quickly spin up the newly assembled capability at a new location.

Airlift assets and deployment capacity can be made available today, but most often this ready availability presumes an extremely high priority, such as a Presidential order or a critical emergency. Likewise, individual bases can be set up quickly today (in a day or two to reach IOC), but such agile operations would need to be carried out by highly skilled, multiskilled, and practiced personnel from Contingency Response Groups (CRGs), and even those units would have the benefit of weeks to months of advance planning for such quick operations.

AB concepts, moreover, call for routinely establishing bases at varying levels of resilience, responsively calibrating the base capabilities to swiftly changing operational environments, and selectively using the rapidly scalable bases for a diversity of operational purposes. In some cases, a base might be inside the adversary's threat range, intended for high-tempo enduring operations, and thus designed to survive an attack and keep fighting. In other cases, a base might be designed for very short-term operations that could be started quickly but stopped within a brief

⁶⁴ Discussions with AF/A4 personnel on November 18, 2016, and December 22, 2016, and with HQ Air Force Installation and Mission Support Center personnel on February 8, 2017. Also see Andrea Jenkins, "Team Moody Tests Capabilities During Week-Long Exercise," Air Combat Command, webpage, December 5, 2017.

⁶⁵ There has been some recent effort in the Air Force to revive this focus on deployment exercises. One particular example is a memo from the commander of ACC directing ACC wing commanders to integrate exercises into their training plans to "practice the skills we will need to execute Adaptive Basing concepts" and "hone the ability to rapidly deploy and employ combat airpower." The memo stated that the intent for these quarterly exercises was "not a readiness inspection, but a means to prepare for rapid deployment for the next fight" (James M. Holmes, *Memorandum for ACC Commanders: Leadership, Initiative, and War*, Joint Base Langley-Eustis, Va.: Headquarters Air Combat Command, June 20, 2017). In another example, HQ AMC recently revived its Mobility Guardian competition, which had been on a hiatus since 2011. See Joseph Trevithick, "USAF's Reboot of Its Huge International Air Mobility Exercise Has Begun," *The Drive*, August 1, 2017.

window of time that would not allow the adversary a chance to target the base. In any case, a commander could elect to shift the intensity of combat operations being conducted from a base either upward or downward, which could require an adjustment to the capability of the base—and a corresponding adjustment to the resource requirements for that base.

Although we focus on the rapid scalability aspects of preparing personnel and equipment for movement to or from one base to another within the theater, we recognize the broader implications, complexities, and challenges of doing so while under attack or threat of attack. At any given beddown base, there will be aircraft in some stage of repair. Thorough consideration must be given to dealing with cases in which some aircraft or personnel will be unable to relocate as a base contracts while employing AB concepts.

How Rapid Scalability Would Support Adaptive Basing

Rapid scalability would give commanders much more precision and control over the deployment process than traditional base buildups. Rapid scalability would allow commanders to quickly pull back forces in the face of mounting threats to preserve the forces to fight another day. It would allow commanders to move in forces rapidly to take advantage of diminishing threats and growing opportunities. It would allow commanders to evade impending attacks by shifting capabilities across the integrated-basing networks. It also would allow commanders to put the efforts where they would be most needed to generate combat power responsively. Finally, rapid scalability would allow commanders to manage the footprint size in the face of adversary threats and thereby maintain the advantage of operational initiative and flexibility, particularly during the initial deployment phases when the political and military situation could be ambiguous and quickly evolving.

Creating the Agile Combat Support Competency to Perform Rapid Scalability

Establishing the ACS competency to rapidly scale base capability requires three changes for the Air Force:

- **prioritizing and sequencing:** Rapid scalability would require the traditional capabilities for deploying forces and establishing operating locations. However, supporting the alternative AB force deployment and employment concepts also would require new deployment priorities. The focus would no longer be on merely speed to deploy (i.e., how quickly a mass of cargo could be transported from point A to point B) but rather on speed to operate (i.e., how quickly a desired level of operational capability could be reached). This new priority on speed to operate would require a corresponding prioritization and sequencing of all deployed base capabilities. New ACS prioritizing and sequencing for

rapid scalability would shift the focus to minimizing time to IOC, subject to a commander's concerns for ensuring adequate protection and recovery capabilities.⁶⁶

- **throughput and airlift assets:** To meet the ACS requirements for rapid scalability, there would need to be sufficiently available and responsive throughput and airlift assets. In some cases, this might require transportation movement resources to be standing by to move forces for scaling a base. The answer to the question of how much is enough would depend greatly on the type of operating locations, the number of operating locations, and the desired closure times.
- **trained personnel:** The deployment agility implied by rapid scalability would require ACS personnel to be trained to support the rapid base buildups and build downs. The ACS personnel training would need to encompass pre- and posttransport processes and skills, such as the physical packing, unpacking, and setting up of equipment at destination operating locations. Some nondeploying personnel perform these tasks as additional duties (commonly referred to as *mobility augmentees*) at home stations when preparing for the initial deployment, but those personnel are not typically available at the deployed location to support additional forward movement or base scaling.

Rapid Scalability in the Context of Base Archetypes

We now estimate the additional airlift requirements and associated transportation times for rapid scalability, and we explicitly link these two sets of estimates to the base archetypes that we introduced in Chapter Four. In addition, we estimate the amounts of modular ACS capabilities that would be required for an integrated base to reach various levels of operational intensity, beddown duration, and resilience.

Airlift Required for Rapid Scalability

As noted in Chapter Four, the four base archetypes could serve as handy yardsticks for ACS requirements in CDO environments. Alternative AB concepts suggest that the capability of a base might need to be scaled up or down as the threat of enemy attack changes over the course of a conflict. Table 6.1 shows the ascending airlift requirements of scaling up the capability of a base from one archetype to the next, assuming no prepositioned assets. (Whether for establishing integrated bases or for rapidly scaling up the bases, the ACS requirements for the base archetypes would ascend in this order: temporary use base, dispersal base, traditional base, stay-and-fight base.) This is not to say a base has to transition in that order: One could go from a temporary use base to a stay-and-fight base, for example.

⁶⁶ The term *form to function* is sometimes used in AB discussions to describe the prioritization process of choosing only what is needed for a given task—i.e., selecting the appropriate ACS form to support the operational AB function. Using this terminology might sound like a reasonable way to follow the traditional military principle of economy of force. However, because base planning over the past 20 years or more has defaulted to the routine establishment of sustained, robust operations in mostly permissive environments, the ACS deployment processes have routinely followed suit, placing the priority on speed to deploy rather than on speed to operate.

Table 6.1. Estimated Airlift Requirements (in C-17 Equivalents) for Rapidly Scaling Up Bases

From/To	Dispersal	Traditional	Stay-and-Fight
Temporary use	15	47	123
Dispersal		32	107
Traditional			76

For instance, as the threat of enemy attack diminishes at a dispersal base in an AB scenario, the combatant commander might wish to scale up the base from one originally intended for limited operations over a short period to a more-established traditional base. The estimated airlift requirement for making that transition would be 32 C-17s, assuming that no assets had been prepositioned. If such assets had been prepositioned in strategic anticipation of scaling up the base, then this airlift requirement for rapid scalability could be significantly less.

Making the transition from one type of base to another would not happen easily. It would require not only transportation resources but also the ability of base personnel to rapidly pack the equipment and resources and move, potentially under threat of attack. Such a transition would require training, skills, and time.

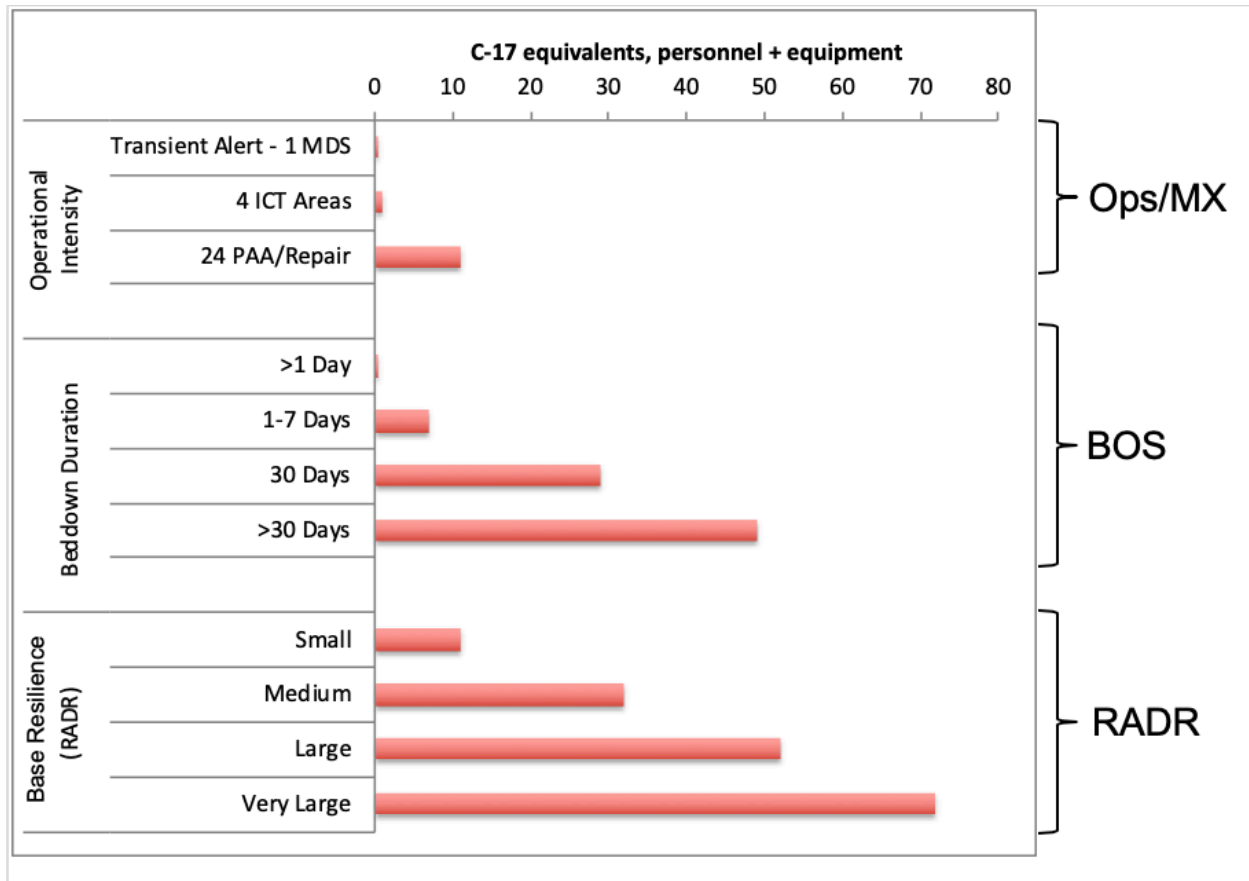
Modular Capabilities Required for Rapid Scalability

Rapidly scaling bases, either up or down, would require the Air Force to think more modularly about force package (i.e., UTC) designs and about the operational and logistical triggers that would prompt the rapid movements of these modular force packages. Current aviation and maintenance UTCs have some modular designs built into them (e.g., deployment echelons discussed in earlier chapters), but most BOS UTCs do not. Moreover, the BOS UTCs constitute a large portion of the current ACS UTCs.

Today's UTC structure is expandable and scalable, but for rapid scalability as AB currently envisions it, ACS planners also would need to develop more-granular force packages that would initially suffice for establishing some level of IOC at the outset, with the option for growing the IOC into a more-robust capability if and when desired. The IOC would suffice for supporting the base population to execute early combat operations but would likely lack several QOL support functions that a more-robust package would contain. The Air Force's legacy force modules enabled that sort of approach but have not been maintained (i.e., currency with today's UTCs), and thus logistics planners do not have a readily available playbook with which to work.

To demonstrate how to think about incremental expansions of modular capability packages for rapidly scaling up bases, we ran the Lean-START model using several different planning factors. Figure 6.1 shows how the movement requirements, in terms of C-17 equivalents, would steadily grow, given the designated incremental increases in ACS planning factors for operational intensity, beddown duration (BOS), and base resilience (rapid ADR teams).

Figure 6.1. Estimated Modular Capabilities Required for Rapidly Scaling Up Bases



NOTE: Ops/MX = operations and maintenance. RADR = rapid airfield damage repair.

For instance, the Air Force initially might wish to scale up a base's operational intensity from a TA status to four turn areas that can operate for seven days with no ADR resilience. Figure 6.1 illustrates this. In this figure, the top, middle, and bottom sections show three separate sets of potential requirements for a deployed location—operations and maintenance, BOS, and rapid airfield damage repair (RADR) for recovering from missile attacks. In each of the three sections, the bars show the number of C-17 equivalents required to transport the personnel and equipment for each selected capability.

In the top section, operations and maintenance, the topmost bar shows the requirement for a very small demand: TA capability for F-16s. The next column shows the requirement for a package to support four ICT areas, also for F-16s. The third bar shows the C-17 demand for a full squadron of F-16s flying sustained sorties with full repair capability and air-to-ground munitions. These three bars are independent; that is, they show the demand for three different force packages.

The middle section shows similar calculations for BOS, and in this case, the variable is deployment duration. The labels show the respective duration for the four bars. As the duration increases, so does the force package size and thus the transport requirement.

The bottom section shows something similar for RADR equipment sets—small, medium, large, and very large. Again, this equipment set is independent of the first two sets of bars.

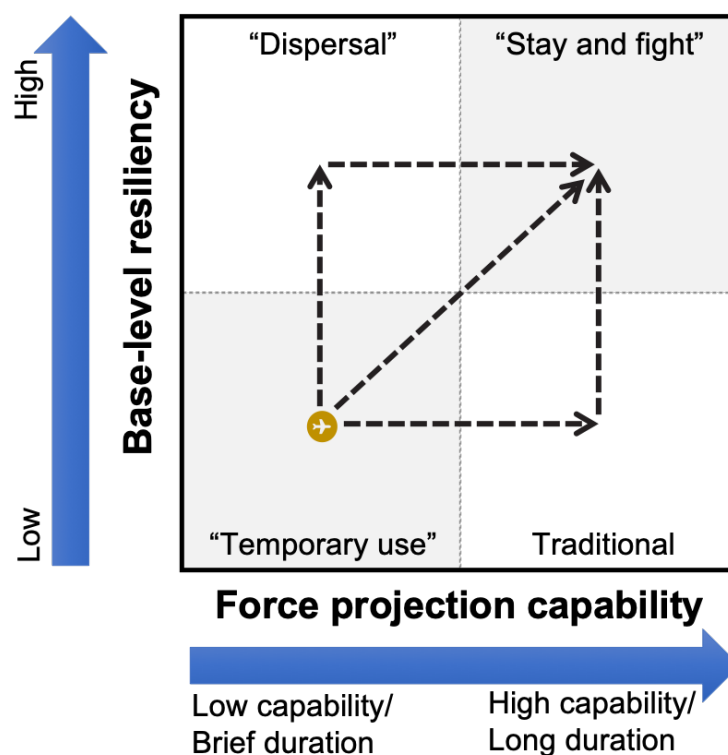
Figure 6.1 helps illustrate how the scaling up of a deployment could be achieved. In each of the three sections, an initial deployment package could initiate operations, and then subsequent deployments could build on that, extending the capability and survivability of the airfield. For the top section, operations and maintenance, from a starting deployment of TA capability (essentially enough to receive incoming aircraft and/or refuel them between sorties), the capability could be scaled up with the addition of eight C-17s of personnel and equipment (one additional C-17 for the ICT areas plus seven C-17s for the weeklong beddown duration). In modular fashion, the Air Force could add a repair capability for 24 aircraft and further extend the base's beddown duration up to 30 days; this further scaling up could be achieved with the marginal additions of about 30 C-17s of equipment and personnel (roughly ten C-17s for the additional repair capabilities under operational intensity plus another 22 C-17s for the additional BOS associated with the month-long beddown duration). Given the size of even the smallest RADR team (shown in the bottom panel of the figure), a commander would have to decide whether it is more important to have an IOC without that protection or whether it is better to wait to start generating sorties until at least a minimal RADR capability could arrive.

Once the IOC is established to operate for at least seven days, the expansion in beddown duration from a weeklong to a monthlong capability could occur gradually. To specify with greater precision the additional expansion time required to achieve the 30-day beddown duration, the Air Force would need to define the expandable modular support levels and build the associated force packages that would allow for the appropriate increments in rapid scalability.

Once again, it is useful to recall that the archetypal quadrants from Chapter Four (in Figures 4.3 and 4.4) compare AB locations along two dimensions: base-level resilience and force-projection capability. Figure 6.1 suggests that rapidly scaling up an AB operating location with augmentations of modular ACS capabilities could incrementally upgrade its base-level resilience, force-projection capability, or both. The delivery of modular ACS capabilities could upgrade the location along the resilience dimension from a temporary use base to a dispersal base, along the capability dimension from a temporary use base to a traditional base, or from a temporary use base to a stay-and-fight base along both dimensions simultaneously, as depicted in Figure 6.2. Likewise, subsequent modular ACS capabilities could enable upgrades along either dimension, from a dispersal base to a stay-and-fight base or from a traditional base to a stay-and-fight base. Theoretically, a base could be scaled up or down from any archetype to any other archetype, such as from a dispersal base to a traditional base or vice versa. Thus, the removal of modular ACS capabilities could spin down any type of base just as quickly as the delivery of modular ACS capabilities could spin up any type of base. Figure 6.2 depicts the types of rapid

scalability that probably would be of greatest utility to combatant commanders responding to a contingency—that is, the scaling up of temporary use, dispersal, or even traditional bases to higher levels of resilience, capability, or both.

Figure 6.2. Rapid Scalability in the Context of Base Archetypes



Obstacles to Fulfilling the Agile Combat Support Requirements for Rapid Scalability

Rapid scalability is primarily about quick, responsive deployments and modulations of base capabilities. In contrast, traditional Air Force planning and practices conduct the deployment and base activation processes on a slower, more-predictable schedule. Today, many deployed bases are designed neither for rapid movements nor for incremental increases in capabilities; they are essentially steady-state locations with enduring presence. More often today, bases are designed from the outset to build up slowly but surely (and thus efficiently) to a desired capability end state because the time frames and available lift enable them to do so.⁶⁷

⁶⁷ For more information about deployment timing and experiences in recent conflicts, see Kristin F. Lynch, John G. Drew, Robert S. Tripp, and C. Robert Roll, Jr., *Supporting Air and Space Expeditionary Forces: Lessons from Operation Iraqi Freedom*, Santa Monica, Calif.: RAND Corporation, MG-193-AF, 2005; Robert S. Tripp, Kristin F. Lynch, John G. Drew, and Edward W. Chan, *Supporting Air and Space Expeditionary Forces: Lessons from Operation Enduring Freedom*, Santa Monica, Calif.: RAND Corporation, MR-1819-AF, 2004.

One key enabler of rapid scalability would be the redesign of bases and force packages. The redesign of bases is sometimes referred to as *form to function*. This element of redesign would require operational and logistics planners to determine a base's most-critical activities and support functions and then strive to keep the base footprint to a minimum. The redesign of force packages would be intended to minimize the time to IOC. Sequencing the deployment movements for incremental buildups in capability would require the current UTCs to be redesigned in a manner that would allow combatant commanders to add modular increases in force-projection capabilities over time.

Rapid scalability to support AB concepts also could require some personnel to be trained in a variety of skills in which they are neither widely trained nor exercised today. Currently, deployment is geared toward regular rotations to known locations rather than rapid responses—and certainly not toward farther-forward relocations from deployed locations. CRGs cross-train on some of these skills, and most personnel in those units can perform the basic tasks that would be required for rapid scalability. Fulfilling the ACS requirements for rapid scalability, however, could require many more ACS personnel to undergo the stalled Phase 1 exercises to become proficient in these skills. Today, it is unknown how many airfields would need to be opened and how quickly, but the larger the number and the faster the required response, the more quickly specialized units, such as CRGs, would be exhausted and the more widely these skills would need to be spread across the force to enable a sufficient response.

Another enabler of rapid scalability would be a network of prepositioned locations for easy access to WRM. The Air Force currently lacks these locations. In an effort to achieve peacetime efficiencies, most WRM storage has been consolidated into fewer sites. Although this consolidation has lessened the cost and effort of peacetime maintenance, it has restricted the availability of WRM for theaterwide, short-notice contingencies. Both PACAF and USAFE are considering more-dispersed postures for WRM, but these ideas are still in the planning stages.

The DoD transportation system is not geared toward rapid, responsive movement, which is an obstacle to rapid scalability. Some DoD airlift capacity is nearly always available to be pulled from an ongoing mission to support a newly critical mission. However, the extremely rapid responses that would be required for rapid scalability could require an on-call transport that would be ready and waiting for action and not previously assigned to some other task. Beyond the absence of any dedicated DoD airlift capacity, there also is no devoted Air Force ground lift capacity for rapid scalability.

Finally, we highlight a formidable obstacle to fulfilling the ACS requirements for rapid scalability. This obstacle is the underlying conundrum—the competition for resources—that is ever present in maintaining a readiness to deploy, but this obstacle would grow even more daunting to overcome with rapid scalability. Often, the people who must operate or train day-to-day also must play a role in the deployment process. Thus, maintaining a high state of operational readiness (e.g., flying many sorties today) competes against the need to maintain a high state of deployment readiness (e.g., quickly packing up and leaving). At home stations, this

competition often is resolved by adding personnel and equipment from units or portions of units that are not imminently deploying. Those nondeploying units can help their sister units prepare for and manage the deployment process, thus freeing the deploying units from the burden of using the same sets of personnel and equipment to perform two jobs more or less simultaneously. In moving from a forward-deployed location, maintenance personnel would be attempting to prepare their equipment and load supplies and toolkits on pallets while trying to repair broken aircraft so they could relocate, or while trying to conduct aircraft mission-generation activities on the flight line. Other personnel on the base likely would be fully employed on their deployment tasks and unavailable to assist with preparing and certifying cargo for air movement (as noted, these tasks typically are performed by nondeploying personnel when deploying from a home station).

This inherent competition between being ready to operate and ready to move has yet to be resolved. For rapid scalability to become viable, the trade-offs would need to be explored. There ultimately might be some “sweet spot” of deployment agility between extreme redundancy and extreme leanness that allows deployed forces to be both ready to operate and ready to move, but the answer is far from obvious. Exploring the inherent trade-offs posed by the competition for resources would be another worthwhile way for the ACS community to support rapid scalability.

7. Implications and Recommendations

Our participation in the Air Force’s effort to define AB and address its challenges—through tabletop exercises; weapons and tactics conferences; and conversations with air component staffs of the major commands (MAJCOMs), SMEs, and Air Staff-level planners—has obliged us to emphasize three implications for the ACS community and three for the broader Air Force.

Implications for the Agile Combat Support Community in Particular

- *The design of current force packages is ill-suited for executing AB concepts.* In particular, current aviation and BOS UTCs are not designed to enable the incremental buildup or builddown of capabilities needed for rapid scalability. Some smaller capability packages do exist in the Air Force, but they are limited to use by special forces.
- *Implementing AB concepts would require the Air Force to develop new competencies for employing ACS capabilities.* The new ACS competencies include those for operating integrated-basing networks, providing multi-MDS-certified aircraft mission-generation maintainers at the integrated bases to support flexible operations, and scaling base capabilities rapidly.
- *Although changes to ACS organization, training, and deployment practices could enable the ACS community to implement AB concepts more efficiently, much work remains to be done to assess the investment, risk, and performance implications.*

Implications for the Air Force at Large

- *Implementing AB comprehensively would represent a fundamental pivot in how the Air Force presents forces to warfighting commands.* Many AB skills or tools are practiced in some way today, while others are within reach with some changes to training, tactics, or emphasis. However, realizing AB as a driving force in Air Force deployment and employment would require the Air Force to shift from how it has presented forces to the warfighting commands over the past 20 years. Because implementing AB in this way would introduce wide-ranging changes, AB would take time to implement and refine.
- *Coalescing around a common view of the intended outcomes of AB could accelerate the implementation process.* The definitions of AB vary widely across the Air Force, but concurrence among planners and logisticians on the beneficial outcomes that alternative AB concepts could offer combatant commanders would help all parties recognize which concepts should be pursued under which circumstances and, thus, which ACS activities would be most helpful. (For example, our framework for characterizing base archetypes could help cultivate a common view of their intended outcomes.)
- *The dynamics of AB would require a renewed focus on mastering the operational art of war.* The operational art of war would encompass contingency planning and execution, tactical C2 for ACS, and the tailoring of traditional and alternative force deployment and employment concepts for each new contingency. Successfully commanding AB missions

would require these skills, but they have atrophied over the years as a result of regular, rotational force deployments to known environments.⁶⁸

The implications for the ACS community lead to two recommendations, while the implications for the broader Air Force lead to one recommendation. By following these recommendations, the ACS community and the Air Force can help turn today's alternative AB concepts into tomorrow's AB realities.

Recommendations for the Agile Combat Support Community

In keeping with the implications for the ACS community expressed earlier, we offer the community recommendations in two corresponding areas. As the AB concept is refined and implemented, the ACS community should focus on

- mission and base force package redesign
- personnel skill design.

Mission and Base Force Package Redesign

The ACS community should consider overhauling the mission and base force packages used for deploying and presenting forces to combatant commanders. The current design of UTCs would not permit the type of modular capabilities and incremental force buildups required by the alternative AB concepts. We suggest a four-step approach for taking on the redesign challenge:

1. Decompose the AB mission demands into their component parts. Specify what the alternative AB concepts demand in terms of mission capacity and duration, human performance and endurance, defense against attacks, and recovery from attacks.
2. Reconfigure the force package building blocks. UTCs should still be the building blocks of force projection, but new UTCs, built to serve the incremental AB mission demands, would better enable AB execution. The configurations of UTC packages would need to become more diverse to match the variety of alternative AB concepts being developed.
3. Train force package designers. Recognition of the UTC package design function as a critical and valued skill could promote the ongoing, dynamic development of new UTCs for the evolving AB concepts intended for a growing diversity of CDO environments.
4. Develop a library of new force module designs. Force modules are predefined packages of multiple UTCs designed to enable planners to identify which UTCs would need to be deployed to perform a particular mission. The ACS community could develop a library of

⁶⁸ The Air Force revised its inspection system in 2014, decreasing the need for units to perform operational readiness exercises in preparation of inspections (see Kevin Ripple, "The New Air Force Inspection System Is Here at Dyess!" Air Combat Command, webpage, September 24, 2014). At about the same time, budget constraints and the resource strain of rotational deployment resulted in the elimination of other traditional exercises aimed at practicing deployment preparations (see Trevithick, 2017). More recently, the Chief of Staff of the Air Force and retired Air Force generals have communicated the need to return to the type of planning and exercises that occurred when the Air Force made the transition to the EAF in the late 1990s (see Trevithick, 2018, and Douglas A. Birkey and David A. Deptula, "Building the Air Force We Need," *Air Force Magazine*, April 15, 2019).

UTC force modules to enable rapid planning and replanning for integrated, flexible, and scalable AB operations.

Personnel Skill Design

The ACS community should consider personnel skill design and personnel development activities that could help fulfill the ACS requirements for AB. Although some cross-training occurs today, it would need to be expanded and be more extensive to enable AB. We see two broad categories of personnel skill design worth noting: basic airmanship skills and more-intensive cross-training.

Basic Airmanship Skills

The first category is what might be called basic airmanship; that is, the skills most airmen should have to deploy capably into an expeditionary environment. It could be argued that, to operate in CDO environments or stand-in bases, airmen require a broader complement of skill sets, but all airmen might require more than the status quo. The following are a few examples:

1. Medical care: The level of medical care training provided to basic airmen is fairly low among the military services and recently was reduced. In 2016, the Air Force conducted an assessment of each of the 61 additional duties identified under Air Force Instruction 38-206 and selected several for elimination or conversion to computer-based training.⁶⁹ Self-aid buddy care training was among the programs reduced.⁷⁰ Recent RAND research on medical operations in denied environments has recommended more rather than less medical training for airmen; this research is unavailable to the general public. We do not advocate here for a specific level of training, but simply urge the Air Force to assess these skills in the context of CDO environments.
2. Protection and defense: The level of weapons training for airmen is also fairly low among the services and includes intermittent qualification on basic weapons, with some additional training or qualification before deploying, especially to higher-threat environments. In a CDO environment, personnel might be called on to fight during a ground attack (i.e., defend their area or move to support more-highly trained security forces) or contribute to recovering the base activities in the event of a missile attack. This category likely would include increased proficiency on basic weapons. Such training might be appropriate only for stand-in bases where threats are higher and/or footprint ceilings are lower, and thus allow for fewer personnel at each base.
3. Deployment agility: Successive forward movements would require materiel and equipment to be reprepared for air or surface movements. Some of the most-basic training and exercising of these skills historically has been accomplished with Phase 1

⁶⁹ U.S. Air Force, *Reducing Ancillary and Computer-Based Training*, memorandum for all airmen, Washington, D.C., October 27, 2016c.

⁷⁰ The self-aid and buddy care (computer-based and in-person training) course is required only prior to deployment or when stationed at high-threat locations rather than every three years (U.S. Air Force, *Fact Sheet: Reducing Ancillary and Computer-Based Training*, Washington, D.C., October 27, 2016b). Self-aid and buddy care monitor and instructor duty was found to be “duplicative of other training provided prior to deployment” and was eliminated (U.S. Air Force, 2016b).

and Phase 2 exercises at the home station. Before the terrorist attacks of September 11, 2001, this training was accomplished regularly. There are other exercises and trainings that were widespread but also have waned (e.g., EAGLE FLAG). Often, the primary justification for this reduced emphasis has been increased time on overseas deployments pushing out time for such training. Deployed personnel might need to be trained to perform these functions if a unit were to deploy farther from its initial forward location.⁷¹

More-Intensive Cross-Training

Beyond basic skills that a broader variety of airmen ought to have, some AB concepts lead to a discussion about having personnel trained and certified in areas outside their primary functions (sometimes referred to as *cross-utilization training*). This could reduce the footprint of a deployed force, increase its deployment speed and agility, alleviate constraints associated with operating from many small bases, and increase the resilience of the force when it suffers casualties. However, not all cross-training would accomplish the same objectives. Many cross-training opportunities exist, and some Air Force research already has been devoted to this subject.

We highlight two areas as potential examples:

1. Mission generation: Mission generation is one area that would require more time and training but could offer great flexibility for operational commanders. Our descriptions of flexible operations suggest that each forward operating location should be set up with four ICT areas to increase sortie generation. Having aircraft maintainers dual-certified would allow for several types of aircraft—as opposed to a single type of aircraft—to recover at a given site. This could apply to very basic TA capability, weapons loading, and fueling. Some units already experiment with some level of maintenance cross-training,⁷² and recent exercises have done the same.⁷³ Furthermore, 2016 RAND research evaluated the potential consolidation of the maintenance Air Force Specialty Code structure for tanker aircraft.⁷⁴
2. Deployment agility: Beyond the basic skills referenced in the previous section on deployment agility, more-advanced skills could include transportation skills, load planning, joint inspection, and forklift operation. Contingency response units already perform cross-training on these skills for most of their personnel.

⁷¹ In the Air Force, a Unit Deployment Manager (UDM) liaises among several stakeholders to ensure that unit personnel are ready to deploy. Previously, this position existed in every unit; after the review of ancillary duties, the UDM position was shifted from one in every unit to the Commander Support Staff (CSS) and will be considered a core task of the CSS. This change could raise the profile of the UDMs and of the training and preparedness they oversee, but more-systemic changes to focus on deployment skills might be necessary.

⁷² Discussions with 100th Maintenance Group personnel at Royal Air Force Mildenhall, August 27, 2018.

⁷³ HQ PACAF personnel have conducted Arctic ACE and Tropic ACE exercises to flesh out PACAF's ACE concept.

⁷⁴ Thomas Light, Daniel M. Romano, Michael Kennedy, Caolionn O'Connell, and Sean Bednarz, *Consolidating Air Force Maintenance Occupational Specialties*, Santa Monica, Calif.: RAND Corporation, RR-1307-AF, 2016.

This discussion raises questions about the level of expertise required in each circumstance. The Air Force has terminology for personnel and training contexts that is used to denote levels of expertise: familiarity, proficiency, certification, qualification, skill levels (e.g., 3-level, 5-level), special expertise indicator, and more. We do not advocate for any particular term or level of expertise; our sense is that AB concepts are much too immature to settle on such decisions at this point. However, plentiful analogs exist in the Air Force and DoD to provide templates, and further research and experimentation should test and flesh these out.⁷⁵

In either case—basic airmanship or cross-training—an analytic framework is needed to determine which skills are most critical for AB and which could be successfully added or combined and then sustained within one or more career fields. Many skills could be incorporated, but careful analysis should reveal the best path forward.

Recommendation for the Air Force: Experimentation Campaign

The Air Force should consider an experimentation campaign to test various aspects of implementing alternative AB concepts. The goals of this campaign would be threefold, in keeping with the three implications of AB for the Air Force expressed earlier:

1. expedite the pivot toward AB
2. cultivate a common view of the intended outcomes of AB
3. revive the operational art of war.

Experimentation campaigns customarily take an incremental approach to developing and practicing the various elements of new concepts. Such campaigns are structured to accomplish stepwise short-term and long-term objectives through a variety of methods, such as workshops, brainstorming events, tabletop exercises, wargames, simulations, and field experiments. Table 7.1 shows the types of activities that could be part of an experimentation campaign designed to inform and expedite AB implementation. One benefit of such a campaign is that some of the activities and experiments could be conducted in parallel. As a result, real-world implementation could occur faster than it might in the absence of the experimentation campaign.

⁷⁵ One theme that emerged throughout our AB discussions is the existence of other models for developing and sustaining skills and expertise in the Air Force and DoD (as well as in partner nations). Contingency response forces and Special Operations Forces are the most-common examples, but the Army and Marine Corps in particular have different—but compatible—models for skills training that take a different approach to expeditionary operations than the Air Force's current practices.

Table 7.1. Elements of Adaptive Basing Implementation for Evaluation in Experimentation Campaign

AB Implementation Focus Area	Experimentation Activity	Desired Outcome or Objective
Mission and base force package redesign	Workshop or brainstorming	Develop UTCs and force modules to enable implementation of AB concepts.
AB planning and decisionmaking	Tabletop exercise	Gain knowledge of when and how to apply AB tools under various circumstances.
Basing design	Wargames	Assess the effectiveness of various basing design concepts.
Flexible operations and mastering the art of war	Field experiments or exercises	- Evaluate the ability to execute a MAF-like enroute support structure for the CAF. - Assess the ability to conduct FARP-like operations. - Evaluate tactical C2 concepts of AB.
AB execution	LVC simulations	Identify gaps and needed improvements in the execution of alternative AB concepts.

NOTE: LVC = live-virtual-constructive.

Air Force leaders should view the experimentation campaign as an opportunity to think about how to implement AB and to better understand which AB concepts provide value and which do not. The experimentation campaign also would allow the service to better understand how the AB challenge would require servicewide changes in how the Air Force accomplishes four broad operational tasks. All four tasks could be explored and evaluated through an experimentation campaign. The four tasks are

- planning combat force deployments
- deploying and employing those combat forces
- commanding and controlling those forces
- investing in ACS capabilities.

Planning Combat Force Deployments

AB concepts challenge the current approach to planning force deployments. Current planning practices presume that large volumes of resources should be deployed, paying little heed to how force flows could be modularized to achieve an IOC in theater sooner. Once the forces have arrived in theater and combat operations have commenced, most planning focuses on force sustainment and the flow of additional resources to replace attrited forces and resources at the established bases. In contrast, certain maneuver concepts being considered under the AB umbrella would require subsequent forward deployments of forces beyond their initial beddown

locations or, as an alternative, continuous postattack movements of resources *among* bases and prepositioned storage sites to reestablish full operational and support capabilities at recovering bases. Planning for these types of successive or continuous movements during the course of execution is not something that Air Force planners do as a regular course of business.

Deploying and Employing Combat Forces

AB concepts imply a major shift in how the Air Force would deploy and employ its combat forces. Traditional force deployments are sent to locations that are either established installations or new bases that are built with housekeeping sets designed to convert a very austere location into a base with robust infrastructure and force support capabilities. Under current beddown planning and support policy, the new bases require movements of large quantities of equipment and lengthy setup times before the bases can be made available for conducting operations.⁷⁶ Likewise, today's combat fighter aviation units typically deploy in either 12- or 18-aircraft force packages that are accustomed to arriving at a beddown location and operating from that single location for the duration of a conflict. Current AB concepts challenge all of these traditions.

Commanding and Controlling Combat Forces

Planning and executing responsive, flexible movements of forces and resources as envisioned under AB would place a premium on Air Force C2 capabilities. C2 is generally thought of either in terms of air campaign planning at the strategic level or in terms of air tasking order (ATO) production and execution at the tactical level. AB concepts would require the additional capability to command and control ACS resources both strategically and tactically. For example, to fully leverage the AB tools at their disposal, combatant commanders would require strategic knowledge of what ACS resources were available and where to determine where fighting forces could relocate. Similarly, leveraging individual locations in an integrated-basing network would require tactical knowledge of each location's operational status and sortie-production capability.

Investing in Agile Combat Support Capabilities

The notion of compiling a collection of AB concepts into a toolkit from which combatant commanders could draw to help forces survive and operate in dissimilar CDO environments presupposes (1) strategic investments in multiple ACS capabilities, (2) a framework to correlate the multiple ACS capabilities with suitable AB concepts, (3) a dynamic planning aptitude to make informed decisions about the ACS capabilities while prosecuting a campaign, and (4) a C2 network to provide the data for those decisions. In other words, the AB toolkit would presuppose a variety of servicewide investments to ensure full utilization of the enhanced ACS capabilities.

⁷⁶ Fast setup times are rare. CRGs can set up small bases quickly, but with lots of planning. Humanitarian relief operations can be set up quickly, but they are very purpose-tailored and are not very robust.

The footprint model used for this project could support an experimentation campaign. The footprint model (Lean-START) estimates the personnel and equipment requirements for operating locations.

Considerations for Further Analyses

AB as a concept for force employment and development is in its infancy. This project specifically focused on ACS for AB, but we envision questions about ACS support fitting within a broader research agenda for AB. Specifically, we see the following five questions as key to further exploring and assessing the potential costs and benefits associated with individual AB concepts and groups thereof:

1. **Does AB succeed at improving operational resilience?** One stated goal of AB is to take actions to increase operational resilience, which can include evading detection and targeting by an adversary. Relying on evading (rather than defending against) targeting requires a sophisticated understanding of adversary capabilities and processes, including modes of detection (e.g., signals intelligence [SIGINT], electronics intelligence [ELINT]), capabilities and technologies, thresholds for detection and targeting, and an ability to overcome or avoid those capabilities (e.g., stay small, move quickly, send mixed signals, reduce target value). To date, little research has been done to understand these elements for key near-peer adversaries. Further research would (1) assess those adversary capabilities, Blue capabilities, and gaps and (2) identify and propose solutions.

AB largely substitutes one type of risk for another. In the interest of mitigating the risk of being targeted by enemy missiles, commanders will be asked to accept the following types of risks: insufficient sortie generation capacity or sustainability, insufficient capability to prevent or recover from ground attacks or accidents, and human performance degradation. The relative favorability of these trade-offs is not yet well understood.

2. **Does AB produce sufficient combat power (i.e., capability/capacity) to be worthwhile?** AB or any movement or maneuver concepts challenge basic notions of Air Force power projection. AB concepts might call for operating in small units, operating with little support, operating briefly, and moving periodically. A key question is whether such operating concepts can provide needed combat power; that is, sorties generated over time. Fewer aircraft per base means potentially fewer spare aircraft and poorer maintenance economies of scale. Lean maintenance support could mean stranded aircraft with hard breaks. Moving to another operating location when pilots could be flying means giving up time and attention; personnel must spend time on preparation and movement, which compete with mission generation. To date, research has explored relatively little of the operational capability implications for AB and related concepts. Further research should assess the operational effectiveness of AB concepts for capability, capacity, endurance, and risk. Likely, modeling efforts would need to focus specifically on the size of packages, MDS, sortie duration, deployment duration (e.g., hours, days, weeks), amount of movement, amount of tanker support, and maintenance support concepts.

3. **What support is required or would enable AB?** This report is a first step toward addressing this question, but much work remains. The force package redesign effort, as described in our first recommendation, could be very useful in analyzing whether the Air Force is indeed resourced to execute a war plan that employs alternative AB concepts. The new AB force packages would represent the demand signal with which the Air Force's current inventory of personnel and equipment would be compared. This demand signal could be used to assess the suitability of the current force structure to execute AB operations as expected by combatant commanders and could lead to the quantification of gaps that must be resourced.
4. **What will sustaining and executing AB cost?** Already, many in leadership (particularly at the HQ Air Force) want to know what AB will cost. Often underlying this question are images of stockpiles of equipment, billions of dollars in infrastructure investments, or even end strength, all of which set off alarm bells. Changes to equipping, infrastructure, and manning might indeed follow from further developing AB concepts. We believe that it is premature to focus on such tangible but costly investments, although putting such investments in a Program Objective Memorandum can be satisfying (and show that something is being done to address the challenge).

From this research, we have initially concluded that some investments are indeed necessary, but they should involve the development of new TTPs, training, and time and resources devoted to experimentation, in whatever form that takes.

5. **How will C2 be performed?** AB concepts (and the CDO environments that necessitate them) fundamentally challenge Air Force C2 concepts and practices, from the most-tactical level up to the Air Operations Center (e.g., the design and transmission of the ATO). Much work has been done in the past few years on C2 concepts in degraded environments, and C2 will have to be leveraged and integrated into AB concepts.

There are comparable gaps for ACS. Although the Air Force has made some progress in developing ACS C2 processes and procedures, much of this effort has focused on high-level strategic assessments of ACS capabilities to meet combatant commander demands. AB would necessitate ACS tactical C2, which also should be assessed. ACS tactical C2 deals with directing base resources and aircraft in real time to execute alternative AB concepts, such as flexible operations.

In this chapter, we laid out a daunting set of challenges for the Air Force and the broader defense community to address. Many organizations and personnel have expended much effort developing AB concepts up to this point, and such experimentation continues. But the Air Force will make little progress as long as these efforts remain mostly disconnected and fragmented. It will take a more-concerted, deliberate, and organized effort to flesh out and refine AB concepts into useable warfighting tools. Some concepts within AB might be discarded for reasons of feasibility, cost, or effectiveness, but if the threats perceived today are credible, AB as a toolkit and comprehensive warfighting approach ought to be tested and found wanting rather than declared to be too difficult without sufficient investigation.

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In many potential operating environments, the U.S. Air Force faces adversaries that are increasingly capable of limiting where and how it projects combat power. To persevere in contested, degraded, and operationally limited (CDO) environments, the Air Force is exploring a variety of alternative force deployment and employment concepts under an umbrella initiative called adaptive basing (AB). Upon surveying the variety of concepts categorized as part of AB, the authors found that all of them—adaptive or not—can be characterized as survival strategies. AB is less about increasing the adaptiveness of aircraft and air forces than it is about extending their survivability through strategies that are both traditional and adaptive.

In this report, RAND researchers review the motivations for AB, describe a footprint model used for estimating the AB implications for Agile Combat Support (ACS), estimate the ACS requirements to perform three fundamental competencies that can enable AB concepts, consider the obstacles to supporting those requirements, and discuss recommendations for the ACS community and the Air Force at large.

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