CHAPTER

4

Department of the Air Force

Overview

The Department of the Air Force includes the Air Force's active component, the two parts of the service's reserve component—the Air Force Reserve and the Air National Guard—and all federal civilians employed by the Air Force. It is the smallest of the three military departments in terms of both number of personnel and operation and support (O&S) budget.

The Air Force is responsible for the majority of the U.S. military's air power. However, each of the military services has a substantial number of aircraft; thus, the Air Force's specialty is not simply providing air power but providing a wide range of capabilities and types of aircraft. In addition, the Air Force is responsible for most of the U.S. military's space assets and for the ground-based ballistic missiles that carry about one-third of the United States' deployed nuclear weapons.[1]

The Air Force operates a fleet of aircraft of widely varying sizes that are designed to accomplish a broad array of missions. Types of aircraft unique to the Air Force include long-range bombers, large transport aircraft, and large tanker aircraft. (The other services operate a number of smaller cargo and tanker aircraft, but the Air Force's are bigger and more numerous.) The Air Force also operates a large number of fighter and attack aircraft; aircraft that provide capabilities for airborne command and control, intelligence, reconnaissance, and surveillance (ISR), and electronic warfare (EW); and helicopters and tilt-rotor aircraft for combat rescue and special-operations missions. In addition, the Air Force operates a fleet of unmanned air systems (drones) that can carry equipment for ISR and EW missions as well as weapons to attack ground targets. Because the Air Force's aircraft are expected to operate mainly from established air bases, their designs do not have to give up performance capabilities in exchange for specialized adaptations, such as the ones that enable the Navy's aircraft to operate from aboard ships. The Air Force is also responsible for most of the military's space systems that provide important support to the entire Department of Defense (such as Global Positioning System satellites).

Combat units in the Air Force are generally organized as squadrons of aircraft. Those squadrons vary widely in size—with anything from 8 to 24 aircraft being common—as well as in types of aircraft. Such variation makes it difficult to provide a single measure of force structure for the Air Force similar to an Army brigade combat team or a Navy carrier strike group. For consistency, the Congressional Budget Office focused in this analysis on notional squadrons of 12 aircraft each.[2] The Air Force's planned numbers of aircraft and personnel equate to roughly 220 such squadrons during the 2017–2021 period (see Table 4-1). The Air Force also includes support units (the vast majority of which are used to support combat operations by aircraft squadrons) and administrative units (almost all of which exist to create or maintain the service's combat units and support units).

1. As noted in Chapter 3, the Navy's ballistic missile submarines carry roughly the other two-thirds of the United States' deployed nuclear weapons. Air Force bombers can also carry nuclear weapons, but because of the conventions used in arms control agreements, bombers are counted as carrying very few such weapons (officially, just one nuclear warhead each). Those conventions reflect a judgment that bombers are less dangerous in a crisis because they take much longer to reach their targets than ballistic missiles do and they can be recalled after they have been launched, which is not the case for ballistic missiles.

2. CBO decided to use a notional squadron of 12 aircraft as a standard measure simply to provide a normalized "apples to apples" way of comparing the sizes of different fleets of aircraft (and changes to those fleets over time). Actual counts of Air Force squadrons do not provide such a measure. A simple count of the number of official "slots" in each fleet would provide the same benefit analytically and is a fairly common way of describing the Air Force's fleets. Had CBO used that metric, its estimates for the personnel and costs of each type of Air Force aircraft would be the same as those presented here but divided by 12 in each case.

Table 4-1.

Number of Major Combat Units in the Air Force, 2017 and 2021

	2017	2021
Tactical Aviation Squadrons	101	100
Bomber Squadrons	9	9
Airlift Squadrons	42	43
Air Refueling Squadrons	36	36
Unmanned Air System Squadrons	35	30

Source: Congressional Budget Office, using data from the Department of Defense's 2017 budget request.

All units presented are notional squadrons of 12 aircraft (actual squadrons vary in size).

In addition, the Air Force contains some smaller organizations that provide capabilities unrelated to aircraft or space systems. The most noteworthy include squadrons of Minuteman ballistic missiles, special-operations forces, and squadrons of construction engineers.

Distribution of Air Force Personnel

Of the nearly half a million military personnel serving in the Air Force as a whole, 29 percent are in support units and 37 percent are in combat units (see Table 4-2). The rest belong to units that perform various overhead functions, such as training and maintenance.

More than the other services, the Air Force integrates the personnel from its active and reserve components very tightly—in many cases, it is misleading to treat the Air Force as composed of separate active- and reserve-component units. Many Air Force units are "multi-compo" (multiple component) units, made up of personnel and equipment from both the active and the reserve components. In other cases, equipment assigned to one component may be operated by personnel from the other component. About one-third of the Air Force's aircraft are assigned to the reserve component, which more closely resembles the Army's practice than that of the Navy or Marine Corps. The Air Force's reserve component is also unusual in that its pilots, unlike reservists in the other services, are frequently more experienced than their active-component counterparts.[3]

Such tight integration—combined with the way in which budget information is presented in DoD's Future Years Defense Program (in which units must be classified as belonging to one component or the other, even when that is not strictly the case)—limited CBO's ability to produce meaningful estimates of costs for active- or reserve-component squadrons. Instead, the costs presented in this report for Air Force squadrons represent those of "average" squadrons, even though there may be no actual squadrons with those precise sizes and costs.[4]

Command Levels and Units

Today's Air Force typically does not operate with formations larger than squadrons. In the past, the service relied more heavily on wings (groups of three squadrons, with 24 aircraft per squadron). It also experimented with a larger formation, called an air expeditionary force, composed of several different types of squadrons. Currently, however, the Air Force generally deploys a group of squadrons organized for a specific mission, with higher-level commands such as wings used to provide command and control for the deployed squadrons. As noted above, squadron sizes vary greatly, making counts of squadrons a somewhat misleading measure of force structure, which is why CBO translated all Air Force units into notional 12-aircraft squadrons for this analysis.[5]

3. Statistically, the most important determinant of a pilot's proficiency is total hours spent flying during a career. Pilots in the Air Force's reserve component are almost always former active-duty military pilots, many of whom have gone on to careers in civilian aviation; as a result, they have often spent more hours flying than active-component pilots.

4. For example, about one-quarter of the Air Force's fleet of C-17 cargo aircraft is assigned to the reserve component. However, cargo aircraft are commonly crewed by personnel from both the active and the reserve components, so it would not be accurate to treat one-quarter of C-17 squadrons as being in the reserve component and the other three-quarters as being in the active component (in actuality, about 90 percent of the personnel assigned to C-17 squadrons are reserve-component personnel). For that reason, CBO calculated per-unit costs for this report by estimating the cost of a single notional C-17 squadron rather than by estimating one cost for the C-17s assigned to the reserve component and another cost for the C-17s assigned to the active component. Although that approach almost guarantees that the estimated cost of a notional squadron does not reflect the cost of any actual squadron, if the Air Force made large cuts or additions to its forces that were not disproportionately targeted toward one component or the other, CBO's notional cost would approximate the average savings or additional cost per squadron cut or added.

5. Today, larger aircraft, such as cargo lifters and bombers, are generally grouped into smaller squadrons, whereas tactical aircraft tend to be grouped into larger squadrons. However, squadron sizes are not standardized even for specific types of aircraft. For example, although fighter aircraft are often described as organized into squadrons of 24 aircraft, the Air Force actually organizes F-16s in squadrons of 15, 18, or 24 aircraft.

Table 4-2.

Average Distribution of the Department of the Air Force's Military Personnel, 2017 to 2021

Number of Personnel

	Active Component	Reserve Component	Total
Combat Units	98,000	86,000	184,000
Support Units	100,000	40,000	141,000
Overhead[a]	119,000	48,000	167,000
Total	**317,000**	**174,000**	**491,000**

Source: Congressional Budget Office, using data from the Department of Defense's 2017 budget request.

Numbers may not add up to totals because of rounding.

a. "Overhead" refers to administrative units as well as to personnel not assigned to any unit.

Support units in the Air Force have also evolved over time. In the past, a wing was a relatively fixed organization with a definite support structure, organized into several functional groups, such as an operations group or an aircraft maintenance group. Although modern wings still have functional support groups, those groups vary in size depending on the numbers and types of squadrons they need to support (which also differ in size and type). Moreover, detachments can be split off from those groups fairly easily to support individual squadrons when they deploy. Thus, in practice (if not in formal structure), the Air Force has shifted to using a number of smaller, more flexible kinds of support units that are capable of supporting individual squadrons rather than entire wings.

One reason that is cited for the decline of the wing and the rise of the squadron as the Air Force's main element of force structure is that traditional tactical fighter wings were large and homogenous (generally composed of a single type of aircraft). As tactical aircraft became more expensive, more capable, and less numerous, 72-aircraft wings came to be seen as relatively inflexible, cumbersome units. Similarly, as the Air Force began conducting more sophisticated operations with different types of aircraft working together, mixed forces (a "composite wing") became more useful than forces consisting of just one type of aircraft. In a sense, that shift has brought the Air Force closer to the way in which the other services handle aviation. For example, most of the Army's aircraft are in aviation brigades that contain more than one type of helicopter; the Navy has always used composite carrier air wings, which include several smaller squadrons of mixed aircraft types; and the Marine Corps has long used Marine aircraft wings that are intended to be divided into smaller, task-organized groups for deployments.

At various times in the past decade, the Air Force has suggested a new form of higher-level organization: an air expeditionary force or, more recently, an air and space expeditionary task force. So far, however, those formations appear to be largely administrative conveniences (essentially, lists made in advance of disparate units that would be deployed together for an operation) intended to bring some predictability to the deployment of Air Force units. In practice, the Air Force appears to be evolving toward a system more like that of the Marine Corps, in which actual deployments involve task-organized formations drawn from standing units. Current Air Force doctrine supports creating ad hoc squadrons or wings during deployments. For example, a deployed force of fewer than 700 personnel would warrant having one squadron, but if that force grew to exceed 700 personnel, commanders would be expected to form a second squadron and split assets and responsibilities between the two.

Like the other military services, the Air Force differentiates between the total number of fixed-wing aircraft it has and the number of official "slots" for those aircraft in its force structure. For instance, a squadron of 12 aircraft is intended to be able to operate that many aircraft at all times (in other words, it has 12 slots, called the primary aircraft authorization). But it may have more aircraft assigned to it (called the primary mission aircraft inventory) so the squadron can continue to operate at full strength even if some of those aircraft require extended maintenance or are otherwise unavailable. Similarly, the services have many aircraft that are not assigned to combat units—some are at maintenance depots, some are assigned to training squadrons, and some may be in storage to serve as replacements if aircraft are lost in the future. For those reasons, a service's total aircraft inventory is greater than its primary aircraft authorization levels. (For example, the United States purchased 21 B-2 bombers but maintains 16 slots for B-2s in the force structure.) In this report, all aircraft numbers represent primary aircraft authorizations.

Strengths and Limitations of U.S. Air Forces

Each type of aircraft has its own strengths and weaknesses, but overall, Air Force squadrons are exceptionally powerful units. Very few other countries' air forces have sufficient combat power to consider challenging U.S. control of the air; in many of the conflicts that the United

States has engaged in over the past few decades, opponents have chosen to safeguard their air forces by keeping them grounded for the duration of the conflict. In addition, few nations currently have ground-based air defenses capable of seriously hindering U.S. air operations. The United States has faced only limited competition from hostile fighter aircraft since 1950 (when China intervened in the Korean War), and it has been able to overcome every opposing country's air-defense systems. In the majority of U.S. conflicts since World War II, U.S. air forces have been able to operate essentially at will, either from the beginning of the conflict or a short time thereafter, once the opponent's air defenses had been destroyed.[6] (For a discussion of those and other past military operations, see Appendix C.)

The United States has historically had a lower threshold for using air and naval forces in combat than for using ground forces. And although flexibility and response time have made aircraft carriers a commonly used option for conducting aerial attacks in small interventions, Air Force aircraft have played a role in almost every U.S. conflict since the service was created. Through international agreements, the United States has access to an extensive network of air bases around the world. In addition, the Air Force's tanker fleet is capable of extending the range of Air Force aircraft to allow attacks on almost any possible hostile country. Air Force squadrons can also be deployed more quickly than ground forces, and their ability to fly at high speeds to distant locations allows them to put virtually any location at risk of attack (provided that its air defenses have been sufficiently degraded or can be avoided).

Views on the use of air power have long fallen into two major camps, one focused on strategic airpower (generally associated with the Air Force) and the other focused on tactical airpower (generally associated with the other military services). Both schools of thought agree that the first priority in any air campaign is to destroy enemy fighter aircraft and air-defense systems to ensure that U.S. air forces can operate freely in enemy airspace. Beyond achieving air superiority, however, the two schools have very different views on the form that airpower should take and the way it should be used in a conflict; they also have very different historical records. (The terms "strategic airpower" and "tactical airpower" originated from a time when the former was largely synonymous with long-range bombers and the latter with fighters. Modern aircraft have blurred that distinction, so those terms might be more accurately called "strategic use of airpower" and "tactical use of airpower." However, CBO uses the more common terms here for simplicity.)

Strategic Airpower. Strategic airpower is a catchphrase for attempts to use air power to win a conflict directly—independent of naval and ground forces—either by severely limiting an opponent's ability to conduct effective military operations or by coercing the opponent's leaders into acceding to U.S. demands. In that school of thought, the main way to achieve those ends is generally through bombardment of "strategic" targets, such as command-and-control assets, infrastructure, or key components of an adversary's economy. Consequently, proponents of strategic airpower have historically favored long-range bombers (although it is possible to employ tactical aircraft to attack strategic targets) and have regarded attempts to use airpower to influence ground battles as a diversion from the primary air campaign of a conflict.

The effectiveness of strategic airpower has been hotly debated for decades. Proponents cite a number of theories and point to various examples—such as the ending of World War II after U.S. nuclear attacks on Japan and the 1999 air campaign intended to force Serbia to withdraw from Kosovo—as evidence that air forces can win wars largely independent of naval or ground campaigns. Proponents generally also assert that having the ability to win wars through the use of strategic airpower is a highly appealing strategy given U.S. preeminence in the air and the tendency of airpower to result in fewer U.S. casualties than traditional ground campaigns. (Some advocates of strategic airpower also contend that, in an era of precision munitions, an air campaign can result in fewer enemy civilian casualties as well, making it a more humanitarian option than a ground campaign. That position is controversial, however.)

The use of air forces alone to conduct strikes on opposing states, without the commitment of U.S. or allied ground forces, has had mixed results in achieving the United States' strategic goals. Although air strikes or cruise missile strikes by themselves have sometimes been able to achieve more limited U.S. goals, opponents of strategic

6. A notable exception was the Vietnam War, in which the U.S. military did not maintain a vigorous effort to neutralize North Vietnam's air defenses. Despite those defenses, the United States was able to conduct substantial air operations.

airpower point to numerous operations without ground forces in which the United States failed to achieve its aims. Examples include U.S. bombing of North Vietnam between 1969 and 1973 and cruise missile attacks in Afghanistan and Sudan in 1998 (Operation Infinite Reach). Some theorists have argued that the credible threat of attack by ground forces is a necessary component of a strategy focused on strategic air attacks. In recent years, the United States has often sought out local ground forces to assist in operations that do not involve U.S. ground forces, as it did in Afghanistan in 2002 and Libya in 2011 and as it has recently tried to do in Syria.

Tactical Airpower. Tactical airpower is a catchphrase for attempts to use air power in support of naval and ground forces, to assist in winning a conflict by amplifying the power of those forces (generally through attacks on an opponent's ground forces or naval vessels). Proponents of tactical airpower have historically favored short-range fighter aircraft (although bombers can be used in this role as well) and have regarded attempts to use air power to prosecute a separate air campaign as a diversion from the primary naval or ground campaign in a conflict.

Tactical airpower is often described as having a powerful synergy with ground forces. The reason is that methods for defending against ground forces make an opponent more vulnerable to attacks from the air, and methods for defending against attacks from the air make an opponent more vulnerable to ground forces. During the combat phase of Operation Iraqi Freedom, for example, DoD sources frequently illustrated that synergy when describing how U.S. ground forces could pressure Iraqi units to respond to their assaults. Hostile ground forces are more vulnerable to airpower when they are moving (because soldiers are not protected by field fortifications, vehicles travel in clusters on roads, and so forth), whereas they can sometimes resist aerial attack very effectively when they are stationary. But if they are trying to defend against mobile U.S. ground forces, hostile ground forces may need to move to protect key locations or to keep from being surrounded. In a similar vein, hostile ground forces can resist aerial attack much more easily if they are widely dispersed, but such dispersion makes it much harder for them to resist attack from other ground forces. Those synergies mean that combining tactical airpower with ground forces makes the application of tactical airpower much more effective than it would be otherwise. Tactical airpower has also long been thought to be decisive in naval combat. Examples include the United States' experience in such World War II battles as Pearl Harbor and Midway and Britain's experience during the Falklands War.[7]

Although strategic and tactical airpower can be seen as competing approaches, U.S. air forces have used a hybrid approach during recent conflicts, attacking the sorts of targets favored by both groups of airpower proponents. Part of the reason is that modern U.S. air operations have generally been limited not by the number of air assets available (which would force the military to make choices between competing sets of targets) but instead by the amount and quality of information that can be gathered about prospective targets.

What This Chapter Covers

The rest of this chapter presents CBO's analysis of the following major elements of the Air Force's force structure (listed here with the percentage of the Department of the Air Force's O&S costs that they account for):

- Tactical aviation squadrons (33 percent); see page 86.
- Bomber squadrons (10 percent); see page 89.
- Airlift squadrons (15 percent); see page 92.
- Air refueling squadrons (14 percent); see page 96.
- Unmanned air systems (6 percent); see page 100.
- Other units and activities of the Department of the Air Force, such as intercontinental ballistic missiles and special-operations forces (21 percent); see page 103.

This chapter also examines one topic of special concern to the Air Force: the modern U.S. military's strike capability, which allows many different types of aircraft to attack and destroy a wide range of ground targets; see page 105.

7. The Navy and Air Force have had few opportunities to cooperate in large-scale naval battles since World War II, partly because of the absence of significant naval opponents since then and partly because of the capability and large quantity of U.S. naval aircraft. However, in recent years, the two services have developed an "Air-Sea Battle" concept to develop ways to integrate their forces in future conflicts.

Major Element of the Force Structure

Air Force Tactical Aviation Squadrons

	Total	Direct	Indirect	Overhead
		A-10 Attack Aircraft Squadron		
Military Personnel per Unit	1,190	350	440	400
Annual Cost per Unit (Millions of 2017 dollars)	230	80	60	90
		F-15 Fighter Aircraft Squadron		
Military Personnel per Unit	1,540	430	590	520
Annual Cost per Unit (Millions of 2017 dollars)	300	100	80	120
		F-16 Fighter Aircraft Squadron		
Military Personnel per Unit	1,250	450	370	420
Annual Cost per Unit (Millions of 2017 dollars)	220	70	50	100
		F-22 Fighter Aircraft Squadron		
Military Personnel per Unit	2,390	430	1,150	810
Annual Cost per Unit (Millions of 2017 dollars)	470	120	160	190
		F-35 Fighter Aircraft Squadron[a]		
Military Personnel per Unit	2,940	430	1,510	1,000
Annual Cost per Unit (Millions of 2017 dollars)	570	130	210	230

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

a. Because F-35s are not yet in full operational service, their actual costs may differ from the planned costs included in the Department of Defense's budget documents, on which these estimates are based.

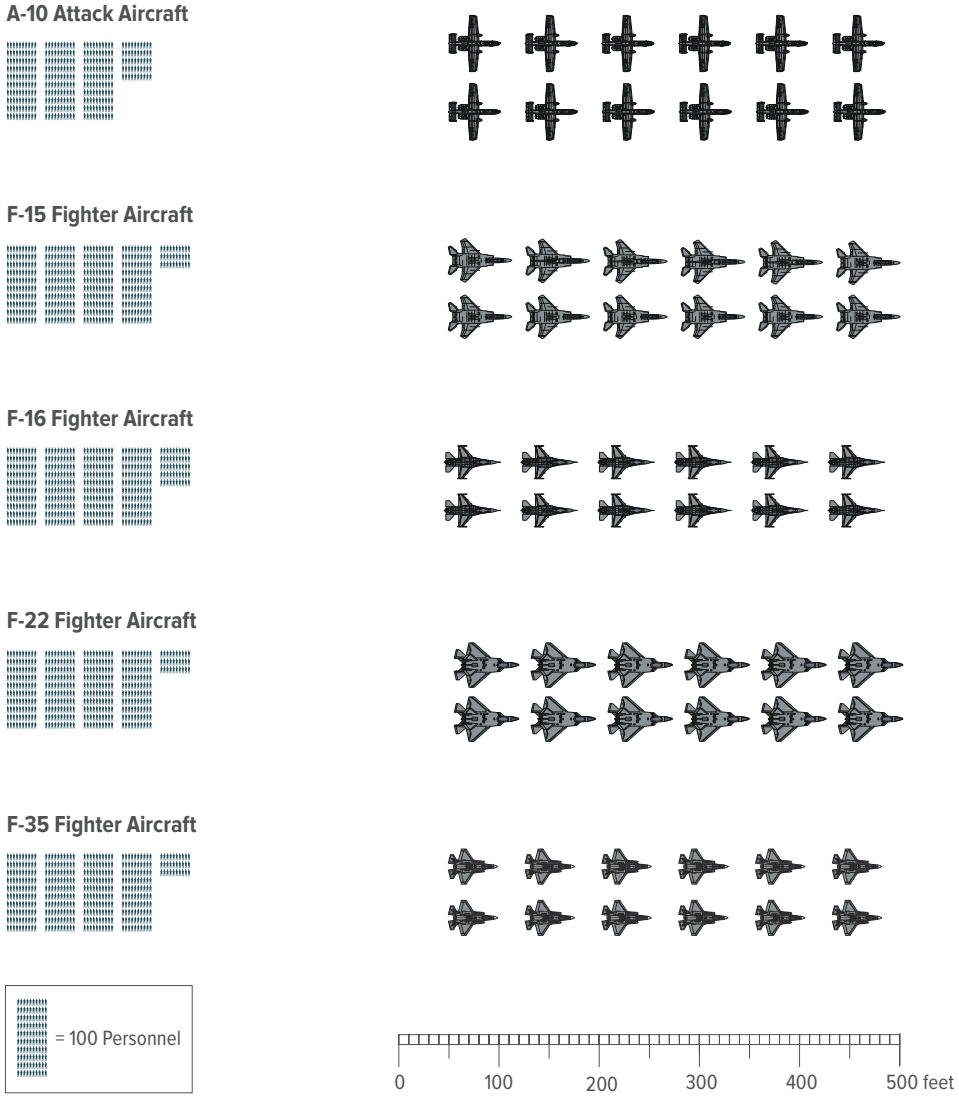
Tactical aircraft, which make up the majority of the Air Force's combat fleet, consist of relatively small aircraft designed to engage in air-to-air combat (fighters), to strike targets on the ground (attack aircraft), or both (multirole aircraft, which the Air Force designates as fighters).

Current and Planned Structure. Between its active and reserve components, the Air Force plans to field the equivalent of about 101 notional 12-aircraft squadrons of tactical aviation in 2017, consisting of 185 attack aircraft (A-10s) and 1,019 fighter aircraft (294 F-15s, 537 F-16s, 157 F-22s, and 31 F-35s). The number of notional squadrons is expected to decline slightly in the next few years, mostly because of the planned retirement of the A-10 fleet, and then rise back to 100 squadrons by 2021 as production of F-35s increases. (For an example of the structure of a tactical aviation squadron, see Figure 4-1.) Tactical aviation accounts for about 33 percent of the Air Force's total operation and support funding.

Purpose and Limitations. In the past, most types of tactical aircraft were highly specialized for either air-to-air or air-to-ground combat. Today, those two forms of combat

Figure 4-1.

Aircraft and Personnel in Notional Air Force Tactical Aviation Squadrons



Source: Congressional Budget Office, using data from the Department of Defense.

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

are still the main roles for the Air Force's tactical aviation fleet, but the most numerous type of aircraft in the fleet is a multirole aircraft (the F-16). Only a small portion of the tactical aviation fleet consists of purely attack aircraft (A-10s). Moreover, the Air Force's newest air-to-air fighter (the F-22) was designed with some ground-attack capability. The emphasis on multirole aircraft is likely to continue in the future with the introduction of the F-35, which was designed primarily to attack ground targets but has air-to-air capability as well. (The ground-attack mission is discussed in detail in the special-topic entry about strike capability on page 105.)

Despite their versatility, multirole fighters are most likely to be used for specific missions according to their individual strengths. For example, F-22 fighters are considered best suited to perform the most difficult air-to-air combat missions, and F-16s and F-35s are best suited to carry out ground-attack missions.

A-10 attack aircraft have almost no air-to-air combat ability; they were designed mainly to provide air support for friendly ground forces (by attacking hostile ground forces engaged in combat). The A-10 is noteworthy for its large cannon, a 30-millimeter (mm) Gatling gun designed for

attacking armored combat vehicles. (By comparison, other types of Air Force tactical aircraft have a 20 mm Gatling gun.) A-10s have good visibility from the cockpit and can fly relatively slowly, factors that give pilots an excellent view of the battlefield they are supporting. However, in recent years, the Department of Defense proposed retiring the A-10 fleet, arguing that those aircraft cannot withstand modern air defenses and are too expensive to maintain in the force.[8]

F-15 fighter aircraft come in several versions, including the C model ("Eagle"), intended mainly for air-to-air combat, and the E model ("Strike Eagle"), intended mainly for ground-attack missions. Until the introduction of the F-22, the F-15C was the Air Force's primary vehicle for achieving air superiority in a theater of operations; it is still considered a highly capable fighter plane. The F-15E model is a relatively large strike aircraft—by the standards of tactical aviation—with a fairly long range and large capacity for carrying bombs and extra fuel.

F-16 fighters are the most numerous aircraft in the Air Force's tactical aviation fleet. Originally designed as a low-cost air-to-air fighter that could operate only during daylight hours, the F-16 has evolved into a very effective multirole fighter that can operate at any time of the day. F-16s are relatively small and lightweight, with a correspondingly limited range and payload capacity. Part of the F-16 fleet has been upgraded with specialized equipment for attacking and suppressing enemy air-defense systems.

F-22 fighters are the Air Force's newest aircraft designed specifically for air-to-air combat. They incorporate "stealth" design characteristics that make them difficult to observe with radar, and they are generally considered the most capable air-to-air combat aircraft being fielded by any nation. The F-22 was initially designed with limited ground-attack capability, but the Air Force has been modifying the aircraft to improve that capability.[9]

The F-35A, the Air Force's variant of the Joint Strike Fighter, is currently in production but is not slated to enter service until 2017 (the first few aircraft are now being used for testing and training). The F-35 is intended to replace the A-10 and F-16 as the Air Force's main tactical strike platform. The largest improvement it provides is stealth; once fielded, it will give the Air Force a large fleet of hard-to-observe strike aircraft. The F-35A will also be capable of air-to-air combat, although not to the same degree as the F-22. Capabilities that the F-35A will not offer are a cannon comparable to that of the A-10 and the slow flying speed useful for finding and attacking ground targets.[10]

Past and Planned Use. The Air Force's tactical aircraft have been used extensively in almost every conflict in which the United States has taken part since the 1940s. Likewise, most potential scenarios for future conflicts are likely to include the heavy use of tactical aviation. In general, tactical aircraft are responsible for securing U.S. control of the air (by destroying an opponent's air forces and air defenses) and for supporting U.S. war efforts by attacking ground targets. In a few cases, such as the enforcement of "no-fly zones," securing U.S. control of the air is the sole mission. That mission is overwhelmingly the responsibility of Air Force tactical aviation.

8. Through prohibitions in national defense authorization acts, the Congress has so far not allowed the Air Force to carry out plans to retire the A-10 fleet. In its 2017 budget request, the Air Force did not propose to retire the A-10 fleet as rapidly.

9. Generally speaking, for a combat aircraft to be stealthy, the bombs, missiles, and other ordnance it carries must fit inside an internal bay rather than being carried externally. The F-22's internal bays are small relative to the size of many air-to-ground weapons (and the aircraft has no external mounting points for such ordnance). Thus, even after it has been upgraded for strike missions, the F-22 will carry smaller amounts of air-to-ground ordnance than other tactical fighters can.

10. Like the F-22, the F-35A will have to carry ordnance in a relatively small internal bay to retain its stealth characteristics, although the aircraft's bay has been sized to accommodate most types of air-to-ground weapons. Unlike the F-22, the F-35 has external mounting points available, so if stealth is not necessary (as may be the case after hostile air defenses have been suppressed), the F-35 can carry an ordnance load comparable to that of other tactical aircraft.

Major Element of the Force Structure

Air Force Bomber Squadrons

	Total	Direct	Indirect	Overhead
		B-52 Bomber Aircraft Squadron		
Military Personnel per Unit	3,830	1,310	1,220	1,300
Annual Cost per Unit (Millions of 2017 dollars)	740	270	170	300
		B-1B Bomber Aircraft Squadron		
Military Personnel per Unit	3,980	940	1,680	1,350
Annual Cost per Unit (Millions of 2017 dollars)	810	270	230	310
		B-2 Bomber Aircraft Squadron		
Military Personnel per Unit	8,660	2,120	3,600	2,940
Annual Cost per Unit (Millions of 2017 dollars)	1,840	670	490	680

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

The Air Force's bomber fleet has two main roles: delivering nuclear weapons and performing strikes with conventional weapons. (Those strike missions are discussed in more detail at the end of this chapter, and the nuclear weapons capability of the U.S. military is discussed in the next chapter.) Historically, the Air Force viewed the delivery of nuclear weapons as the primary purpose of long-range bombers, with conventional strikes as a secondary role. However, events since the collapse of the Soviet Union have generally increased the emphasis on conventional strike missions for the bomber fleet. One of the Air Force's three types of long-range bombers, the B-1B, is no longer capable of delivering nuclear weapons and is now devoted entirely to conventional strike missions. In addition, many of the Air Force's B-52s are slated for conversion to a conventional-only configuration to comply with the New START arms control treaty.

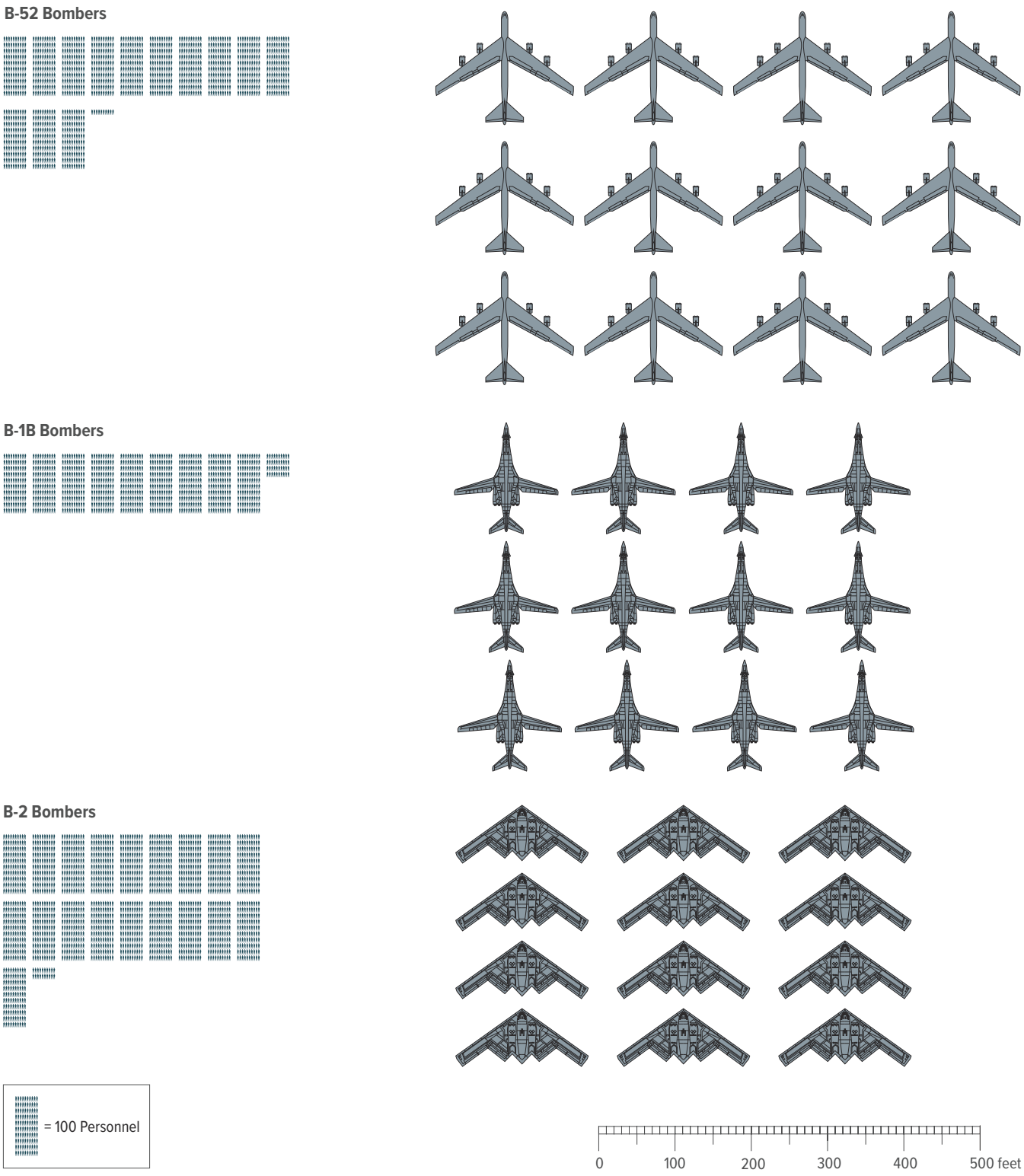
Current and Planned Structure. Between its active and reserve components, the Air Force plans to field the equivalent of about 9 notional 12-aircraft squadrons of long-range bombers in 2017, consisting of 45 B-52s, 51 B-1Bs, and 16 B-2s. It has no plans to change the number of notional squadrons through 2021. (For an example of the structure of a bomber squadron, see Figure 4-2.) Bombers account for about 10 percent of the Air Force's total operation and support funding.

Purpose and Limitations. Unlike tactical aviation, bombers are large aircraft that can travel long distances and loiter above an area for an extended period without refueling (characteristics referred to as endurance) and can deliver a large payload of munitions. Those capabilities make bombers especially well-suited to performing strike missions—their long range allows them to be based relatively far from the theater of operations (freeing up space in closer air bases for shorter-range aircraft); their loitering time lets them remain in an area longer, allowing them to respond more rapidly to requests from ground forces for air support; and their large load of munitions enables them to provide substantial air support before needing to return to bases to rearm.

The enormous weapons payload of the bomber fleet allows it to contribute a very substantial share of the U.S. military's capability to strike targets, despite its relatively small numbers. For example, a B-1B can carry 84 500-pound bombs in a single sortie, whereas an F-16

Figure 4-2.

Aircraft and Personnel in Notional Air Force Bomber Squadrons



Source: Congressional Budget Office, using data from the Department of Defense.

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

could carry 12, although an F-16 typically flies more sorties per day and thus could deliver those 12 bombs more often. However, the Air Force can capitalize on bombers' large payloads only on missions in which enough targets can be identified to use the number of weapons carried.

B-52s are the oldest of the Air Force's bombers, dating to the 1960s.[11] The Air Force plans to keep them in service at least through 2040. B-52s have the ability to carry a great variety of weapons and have the longest unrefueled endurance of the Air Force's bomber fleet. Because of their age, however, B-52s would probably have trouble penetrating modern air-defense systems and thus are best suited to operating in undefended airspace or to delivering cruise missiles from outside defended airspace.[12]

The B-1B fleet is younger than the B-52 fleet, having been built in the 1980s. Although B-1Bs were designed to deliver nuclear weapons, the United States modified them to remove that capability in order to comply with arms control treaties. Today, B-1Bs are intended only to perform conventional strikes. Although they incorporate some features that make them harder to observe than B-52s, they are not considered as capable of surviving in hostile airspace as the more recent B-2s. Nevertheless, the Air Force has used B-1Bs to conduct air strikes in hostile airspace in recent operations—the B-1B fleet delivered more bombs in Operation Iraqi Freedom than any other type of aircraft—albeit often with support from other aircraft.

B-2s are the newest and most modern U.S. bombers. Built in the late 1980s and the 1990s, they are notable for the extensive stealth design features that help them penetrate hostile airspace undetected, and they are considered more difficult to target and attack than other U.S. bombers. However, unlike with other bombers, the Air Force is reluctant to deploy B-2 squadrons to bases overseas, preferring to have them conduct strikes directly from their base in Missouri. Two reasons, according to the Air Force, are the planes' demanding maintenance requirements (associated with the special radar-absorbing coating on the outside of the aircraft) and the need for atmospherically controlled hangars. Nevertheless, the B-2 can be deployed overseas, if necessary, and has been on occasion. In practice, flying most missions from U.S. bases means that B-2 sorties are extremely long and demanding, which limits the number of sorties that the small B-2 fleet (16 aircraft) can conduct to those in which stealth is most essential.

Past and Planned Use. Air Force bombers have been employed with increasing frequency in modern U.S. conflicts. Their use was relatively limited in Operation Desert Storm—B-52s delivered cruise missiles during the initial wave of strikes and conducted some bombing missions afterward—but at the time, the Air Force still saw bombers as primarily dedicated to nuclear missions. Since then, with the collapse of the Soviet Union, bombers have been used in larger roles in more conflicts. For example, the B-1B fleet was first employed for conventional air strikes during the 1990s enforcement of no-fly zones over Iraq; later it was used during operations in Kosovo, in Operations Enduring Freedom and Iraqi Freedom, and in the subsequent occupations of Afghanistan and Iraq. The B-2 fleet was first employed for conventional strikes in Kosovo and was also used during Operations Enduring Freedom and Iraqi Freedom. (It is not clear whether B-2s played a role in the subsequent occupations of Afghanistan and Iraq.) B-52s have often been mentioned as being particularly useful during the occupations of Afghanistan and Iraq because their large fuel load allows them to remain on station, waiting for requests for fire support, for long periods.

11. The earliest models of the B-52 were introduced in the 1950s, but those models have since been retired.

12. Although B-52s have sometimes been used to launch cruise missiles from outside heavily defended airspace, that role is generally performed by the Navy, which has extensive capability to fire Tomahawk cruise missiles from long range.

Major Element of the Force Structure

Air Force Airlift Squadrons

	Total	Direct	Indirect	Overhead
		C-130 Cargo Aircraft Squadron		
Military Personnel per Unit	2,120	800	590	720
Annual Cost per Unit (Millions of 2017 dollars)	360	110	80	170
		C-5 Cargo Aircraft Squadron		
Military Personnel per Unit	2,430	780	820	830
Annual Cost per Unit (Millions of 2017 dollars)	430	130	110	190
		C-17 Cargo Aircraft Squadron		
Military Personnel per Unit	1,390	450	460	470
Annual Cost per Unit (Millions of 2017 dollars)	270	90	60	110

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

The Air Force's fleet of cargo aircraft exists to "airlift" (transport by air) personnel and equipment between or within theaters of operations. Intertheater transport is generally conducted by the larger, longer-range, and more expensive C-5 and C-17 aircraft. Intratheater transport is usually performed by the smaller, shorter-range, and less expensive C-130 aircraft, although the C-17 was designed to operate from shorter runways, making it an option for transport missions between theaters as well.

Current and Planned Structure. Between its active and reserve components, the Air Force plans to field the equivalent of about 42 notional 12-aircraft squadrons of cargo aircraft in 2017, consisting of 292 C-130s, 39 C-5s, and 172 C-17s. That total number is planned to increase slightly, to 43 squadrons, by 2021. (For an example of the structure of such a squadron, see Figure 4-3 on page 94.) Cargo aircraft account for about 16 percent of the Air Force's total operation and support funding.

To supplement its airlift capabilities, the Air Force runs a program called the Civil Reserve Air Fleet (CRAF). Under that program, U.S. civilian air carriers that operate certain models of aircraft receive preferential access to air transport contracts with the Department of Defense; in return, those carriers allow the Air Force to use their aircraft for military transport missions in times of conflict. The CRAF program ensures that the Air Force has a large reserve of transport aircraft available in situations in which it may need more airlift capability than its own fleet can provide. Most eligible U.S. civilian airlines participate in the CRAF program, which generally gives the Air Force access to an additional 400 intertheater transport aircraft and 100 intratheater transport aircraft (although the numbers vary over time).

Because CRAF aircraft are designed for civilian use, they are not suitable for certain military missions, such as transporting the largest armored vehicles. But for some purposes, such as carrying passengers, CRAF aircraft are frequently a better alternative in times of conflict than the Air Force's transport aircraft.

Purpose and Limitations. The primary advantage of moving cargo and passengers by air is that it is much faster than transport by sea. In many scenarios for possible conflicts, the use of air transport would let U.S. forces reach a theater of operations within a day, rather than the weeks that sea transport might require. In addition,

aircraft can move supplies to almost any portion of the globe, whereas many theaters of operations (such as Afghanistan) are far from the sea and would require additional land transportation to move personnel and cargo from ports to the theater. Even in an ongoing operation, the speed and responsiveness of air transport can be extremely valuable in providing logistics support—for example, being able to bring in crucial supplies on a day's notice is preferable to needing a month's notice.

To minimize deployment times, virtually all U.S. military personnel are deployed to and from theaters of operations by air. Moving cargo, however, by air has two major disadvantages. First, cargo aircraft are much more expensive to purchase and operate than the equivalent amount of sea transport capacity. Second, although air transport is less subject to geographical constraints than sea transport, it can be subject to infrastructure constraints, such as limited numbers or quality of airfields. Because the United States has a large fleet of cargo aircraft (and has access to an even larger fleet through the CRAF program) but often operates in regions with poor infrastructure, the Air Force's ability to airlift equipment is frequently limited not by how many cargo aircraft it has but by the quality and quantity of airports available in the theater of operations. Many countries and regions do not have enough airports with the capacity to accommodate the flow of large cargo aircraft the military might need. Often, there are few airports, with small numbers of airstrips of insufficient size or strength and limited facilities for cargo operations. The Air Force has engineering units that can improve the capacity of those airports over time. Nevertheless, in most potential conflicts outside highly developed areas (such as Western Europe, Japan, or South Korea), the capacity of local airports tends to be the factor that limits cargo volume.[13]

Past and Planned Use. The Air Force's cargo aircraft have been employed extensively in every U.S. conflict in the modern era. Notable examples include the use of those aircraft to rapidly deploy elements of the 82nd Airborne Division to Saudi Arabia in 1990 after the Iraqi invasion of Kuwait and the parachuting of special-forces personnel into Afghanistan in 2001 during the early phases of U.S. operations there. The U.S. military has relied especially heavily on air transport throughout its operations in Afghanistan because that country is landlocked, with the closest access to seaports being in neighboring Pakistan.

Most of DoD's potential scenarios for future conflicts envision heavy reliance on air transport. DoD has set several goals over the years for the amount of air transport capability it needs. The analytic measure generally used to assess the capacity of the airlift fleet is ton-miles per day (the ability to transport 1 ton of cargo 1 mile every day). That measure can be difficult to translate into numbers of aircraft because it depends greatly on the characteristics of a given scenario.[14] In general, however, because the U.S. military's ability to transport cargo to a theater of operations is more likely to be limited by the infrastructure in that theater than by the number of aircraft in the Air Force's inventory, a larger inventory of cargo aircraft would allow the United States to support more operations simultaneously or to reduce reliance on CRAF aircraft. Conversely, a smaller inventory of cargo aircraft would either lessen the Air Force's ability to support large operations in multiple theaters simultaneously or require greater reliance on CRAF aircraft.

13. In cases in which a friendly government seeks U.S. protection from hostile neighbors, it is possible to improve infrastructure during peacetime in anticipation of a possible conflict. For example, Saudi Arabia cooperated with the United States to improve its infrastructure for sea and air transport in the 1980s and 1990s so U.S. forces could respond more effectively if the country was threatened.

14. Broadly speaking, scenarios involving more distant locations require more transport aircraft to move a force of a given size in a given amount of time. Thus, the number of transport aircraft needed to respond to a crisis in, say, Southeast Asia would be larger than the number needed to respond to a crisis in Latin America. As a result, the number of transport aircraft that the U.S. military needs depends critically on where DoD foresees crises emerging.

Figure 4-3.

Aircraft and Personnel in Notional Air Force Airlift Squadrons

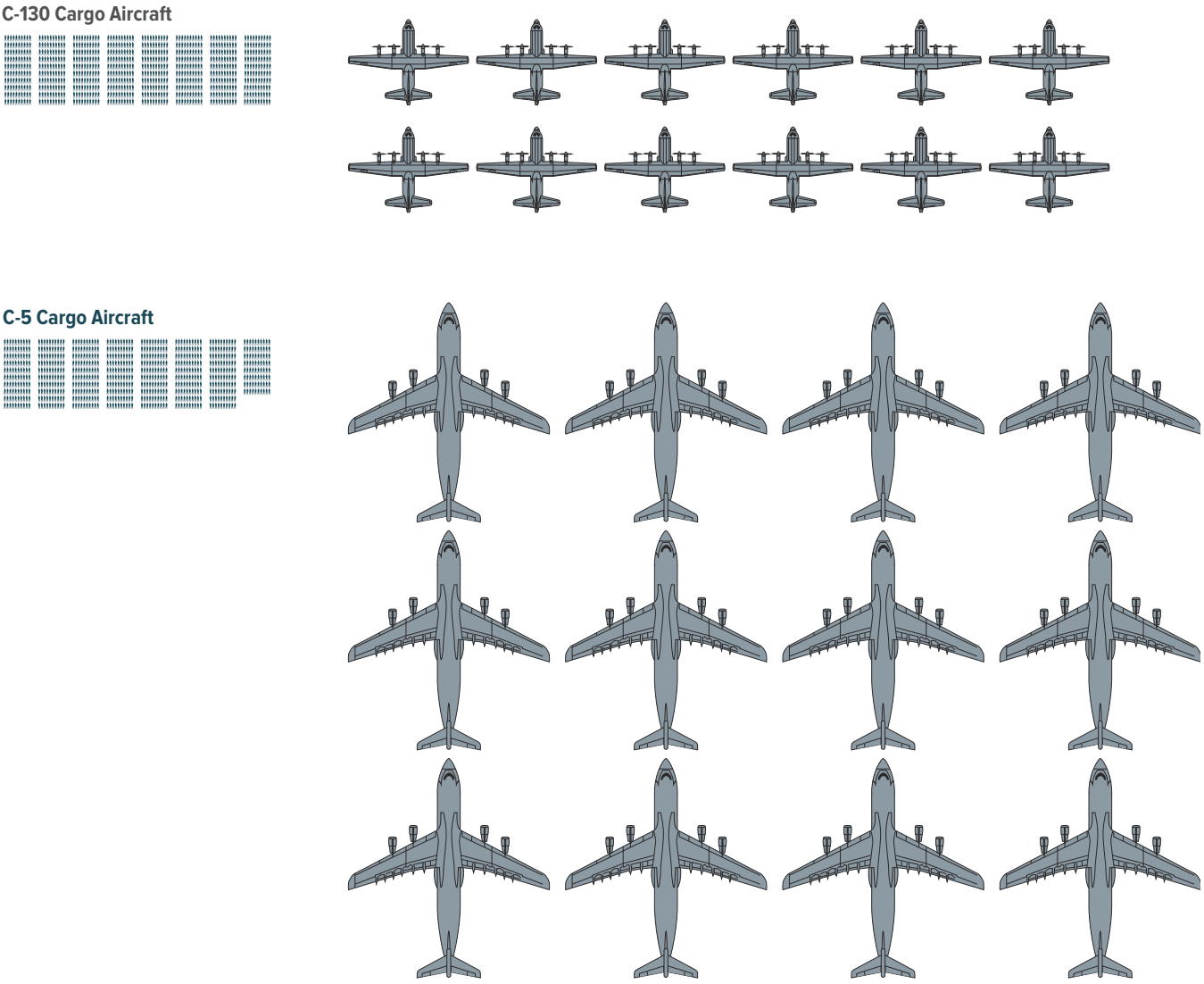


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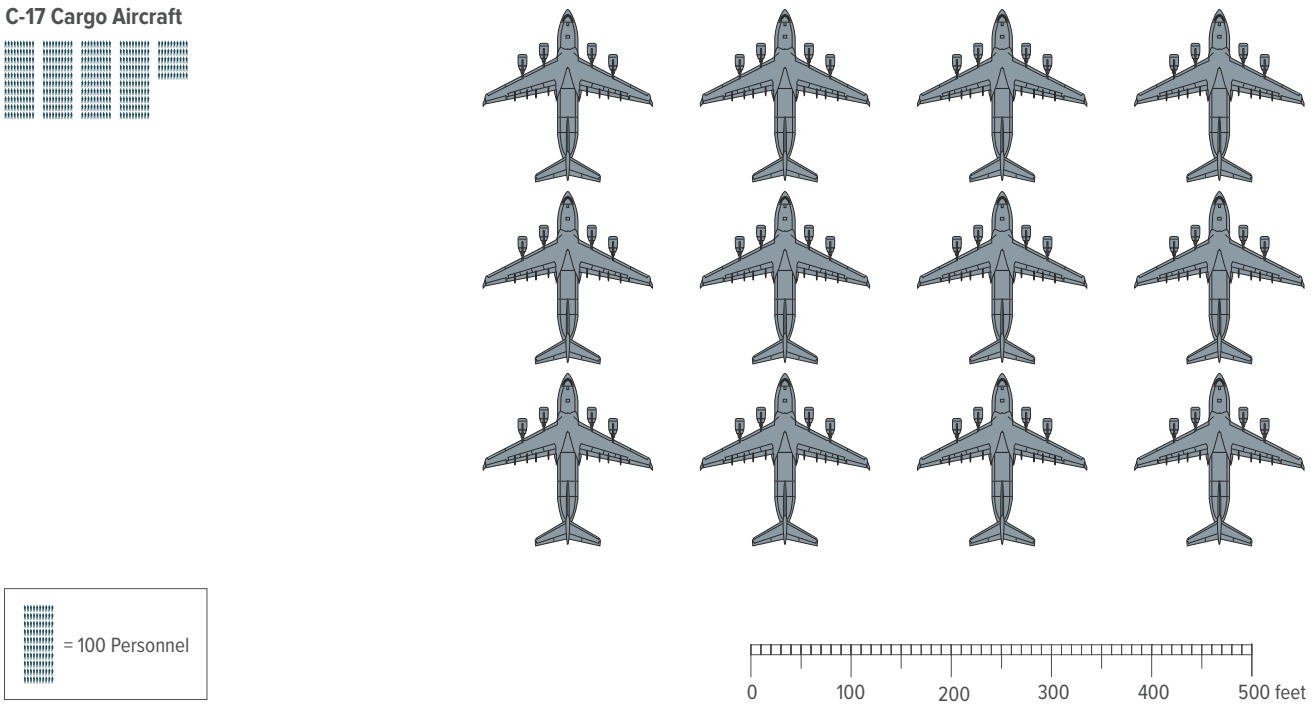
Figure 4-3. Continued

Aircraft and Personnel in Notional Air Force Airlift Squadrons



Source: Congressional Budget Office based on data from the Department of Defense.

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

Major Element of the Force Structure

Air Force Air Refueling Squadrons

	Total	Direct	Indirect	Overhead
		KC-135 Tanker Aircraft Squadron		
Military Personnel per Unit	1,930	610	660	650
Annual Cost per Unit (Millions of 2017 dollars)	360	110	90	150
		KC-10 Tanker Aircraft Squadron		
Military Personnel per Unit	3,140	900	1,170	1,060
Annual Cost per Unit (Millions of 2017 dollars)	580	180	160	250
		KC-46 Tanker Aircraft Squadron[a]		
Military Personnel per Unit	1,070	640	70	360
Annual Cost per Unit (Millions of 2017 dollars)	180	80	10	80

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

a. Because KC-46s are not yet in full operational service, their actual costs may differ from the planned costs included in the Department of Defense's budget documents, on which these estimates are based.

The tanker fleet exists primarily to refuel the Air Force's other aircraft while they are in flight. Although the fleet was originally established to refuel strategic bombers on long-range nuclear strike missions into the Soviet Union, tankers have proved valuable for refueling tactical aircraft in almost every U.S. operation of the post–Cold War era. In addition, all of the Air Force's tankers are capable of transporting cargo as a secondary mission.

Current and Planned Structure. Between its active and reserve components, the Air Force plans to field the equivalent of about 36 notional 12-aircraft squadrons of tanker aircraft in 2017, consisting of 357 KC-135s, 54 KC-10s, and 16 KC-46s. The number of notional squadrons is set to remain roughly steady through 2021 as KC-46 tankers are introduced and some KC-10s are retired. (For an example of the structure of a tanker squadron, see Figure 4-4 on page 98.) Tanker aircraft account for about 14 percent of the Air Force's total operation and support funding.

Purpose and Limitations. Without aerial refueling, tactical aircraft would typically have ranges of only a few hundred miles, so they would have to be based close to their areas of operations, would have less ability to loiter in a location for very long during a mission, and in some cases would have to reduce the weight of the weapons they carried. With aerial refueling, by contrast, the endurance (range and loitering time) of tactical aviation is limited largely by pilots' endurance, and aircraft can be fully loaded with weapons. Those differences increase the utility of tactical aircraft during a conflict in various ways:

- In many theaters, infrastructure constraints limit how many tactical aircraft the United States can deploy near an area of operations. Aerial refueling expands the number of bases from which tactical aircraft can reach a given area, allowing the United States to use more tactical aircraft in a conflict than it could otherwise.[15]

15. Similarly, naval aircraft operating from carriers would be unable to reach areas of operations far inland, such as Afghanistan, without aerial refueling by Air Force tankers. The Navy currently relies on a system known as "buddy tanking" that uses some of the fighter aircraft in a carrier air wing to refuel other fighter aircraft. However, using tactical aircraft in that way offers a much more limited ability to expand the range of tactical aircraft.

- An aircraft's fuel consumption increases when it carries a heavy load of weapons; aerial refueling can reduce the need to make trade-offs between the number of weapons an aircraft can carry and the distance it can carry them.[16]

- In many types of missions, it is beneficial for tactical aircraft to be able to loiter, on call, until needed so they can respond more rapidly to requests from ground forces for air support. Aerial refueling can enhance the U.S. military's effectiveness in those types of missions by allowing tactical aircraft to loiter for longer periods.

- In some large theaters, tactical aircraft would be unable to reach distant targets at all without aerial refueling.

Bombers are larger than tactical aircraft and have longer ranges, but aerial refueling offers some of the same benefits to bomber missions. For example, B-2 bombers require specialized basing infrastructure that makes them difficult to deploy overseas. But with aerial refueling, B-2 bombers can strike targets anywhere in the world from their base in Missouri.

The Air Force's transport aircraft generally do not require aerial refueling, although it is possible and might improve the efficiency of airlift operations in some situations. Aerial refueling also helps U.S. deployments to overseas theaters indirectly by allowing some shorter-range aircraft to "self-deploy" (be flown themselves to the theater) rather than needing to be carried there on a cargo plane or ship.

One limitation of the current aerial refueling fleet is that its tankers are large and slow with few defenses. During a conflict in which the United States had not yet neutralized an opponent's fighter aircraft, tankers would be vulnerable to attack. In practice, however, the United States has not faced any major aerial threats since the end of the Cold War, so that limitation has not been significant.

Another drawback of the U.S. tanker fleet results from the use of two different, and incompatible, methods of aerial refueling. The Navy and Marine Corps employ "probe and drogue" refueling systems on their tankers, fixed-wing aircraft, and rotary-wing aircraft, whereas the Air Force employs a "boom" refueling system on its tankers, tactical aircraft, and bombers.[17] Many Air Force tankers are also equipped to allow for probe-and-drogue refueling, so they can refuel tactical aircraft from the Navy and Marine Corps during operations. However, the need to accommodate both systems in joint operations requires the Air Force to equip some tankers to make them capable of both methods—at a higher cost than would be necessary otherwise—and to coordinate to ensure that the correct types of tankers are assigned to support the correct types of aircraft.

Past and Planned Use. The Air Force's tanker aircraft have been used extensively in every major U.S. conflict since the 1960s. Tankers were especially important in operations such as the invasion of Afghanistan, in which the United States had very limited access to air bases near the area of operations, so aerial refueling was vital to enable the Air Force's tactical aircraft and the Navy's carrier aircraft to attack targets in the theater. Many of the Department of Defense's potential scenarios for future conflicts also envision heavy reliance on aerial refueling.

Although the Air Force's tanker fleet is large, it tends to be quite old. The bulk of the fleet consists of KC-135s built in the 1950s and 1960s. (Until the end of the Cold War and Operation Desert Storm in 1991, the Air Force mainly saw tankers as useful for supporting a nuclear attack on the Soviet Union rather than for supporting tactical aviation in ongoing conflicts.) Leaders of the Air Force have often stated that KC-135s are too old and need to be replaced immediately, but many analysts have suggested that those tankers are in good enough shape to continue serving for many years. Consequently, the major issue relating to the future of the tanker fleet is not its size but the speed with which the Air Force should replace the KC-135 with the new KC-46, which is in development.

16. For example, one specific trade-off is that most tactical aircraft can carry external fuel tanks to extend their range, but those tanks add weight to the aircraft, reduce the number of weapons it can carry, and decrease its in-flight performance. It is generally considered preferable to minimize the number and size of external fuel tanks, and aerial refueling often allows that.

17. In probe-and-drogue systems, the tanker tows a hose with a receptacle at the end, and the receiving aircraft has a probe that fits into the receptacle. Such systems are relatively lightweight, can be fitted on smaller aircraft, and can refuel more than one small plane at a time. They are also the only option for refueling rotary-wing aircraft. In boom systems, by contrast, the tanker has a boom that fits into a receptacle on the receiving aircraft. Those systems are relatively heavy, are only fitted on larger tankers, and can refuel just one aircraft at a time. However, they also transfer fuel more quickly and are the preferred method for refueling large planes, such as bombers or cargo aircraft.

Figure 4-4.

Aircraft and Personnel in Notional Air Force Air Refueling Squadrons

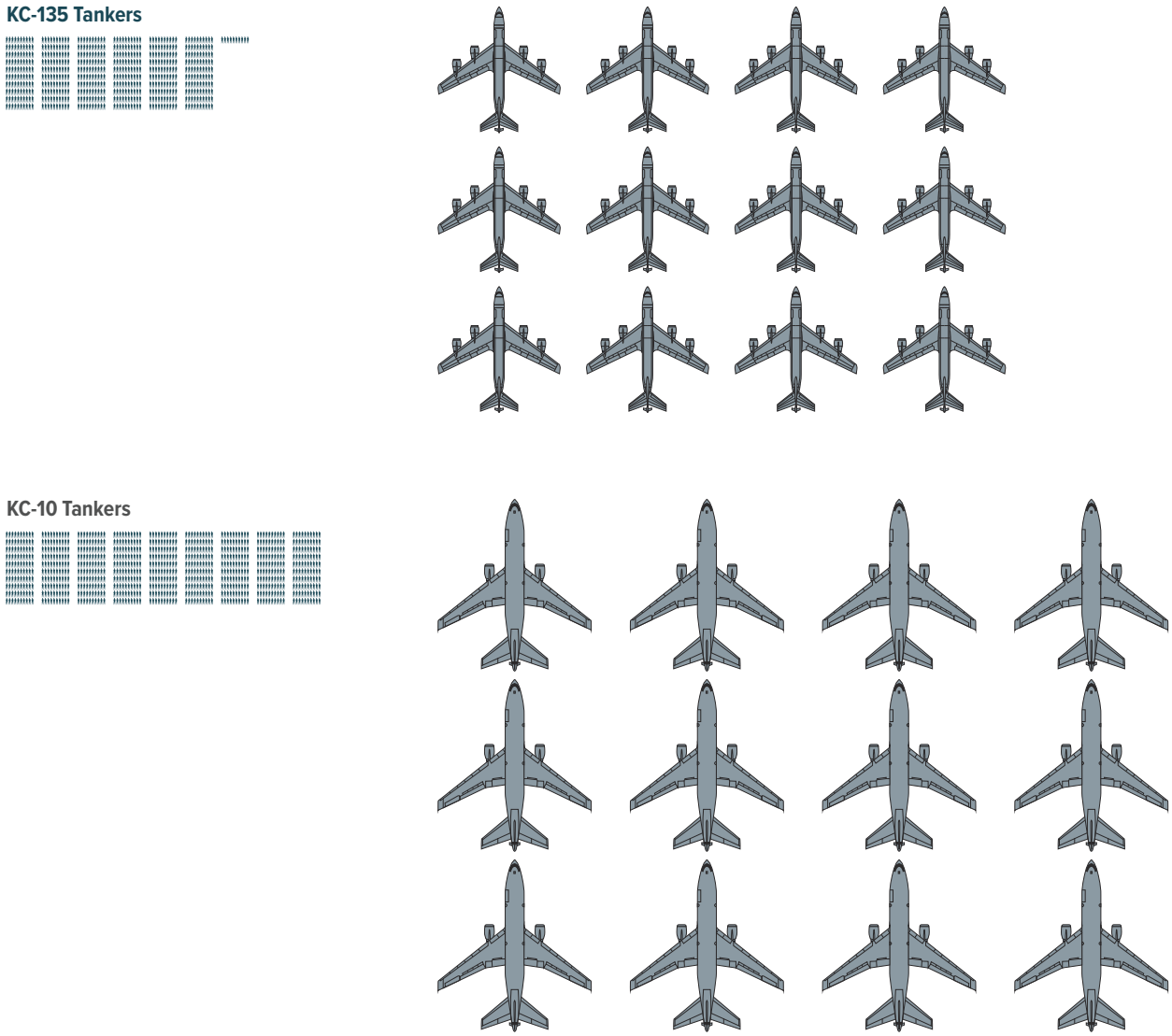


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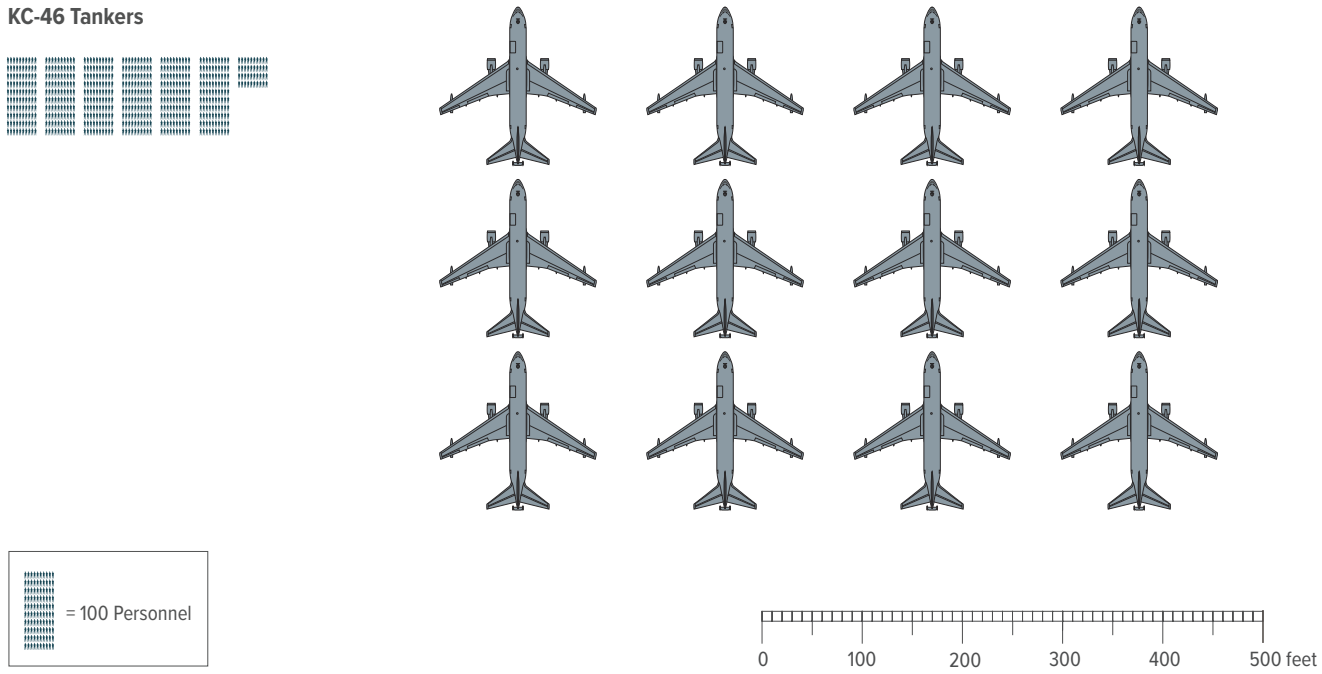
Figure 4-4. Continued

Aircraft and Personnel in Notional Air Force Air Refueling Squadrons



Source: Congressional Budget Office, using data from the Department of Defense.

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

Major Element of the Force Structure

Air Force Unmanned Air System Squadrons

	Total	Direct	Indirect	Overhead
		MQ-1 "Predator" Squadron		
Military Personnel per Unit	260	90	80	90
Annual Cost per Unit (Millions of 2017 dollars)	70	40	10	20
		RQ-4 "Global Hawk" Squadron		
Military Personnel per Unit	1,840	470	750	630
Annual Cost per Unit (Millions of 2017 dollars)	440	190	100	140
		MQ-9 "Reaper" Squadron		
Military Personnel per Unit	920	340	270	310
Annual Cost per Unit (Millions of 2017 dollars)	160	50	40	70

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

The Department of Defense uses unmanned air systems (UASs)—also known as unmanned aerial vehicles or drones—mainly for surveillance and intelligence gathering. Each of the military departments operates a variety of unmanned aircraft, but the Air Force's models tend to be larger and to possess greater endurance and payload capacity.

Current and Planned Structure. Between its active and reserve components, the Air Force plans to field about 75 notional 12-aircraft UAS squadrons in 2017. Those aircraft consist of 110 MQ-1s, 36 RQ-4s, and 279 MQ-9s. The number of notional squadrons is expected to decline to 30 by 2021 as the Air Force retires its MQ-1s. (For an example of the structure of a UAS squadron, see Figure 4-5.) Unmanned air systems account for about 6 percent of the Air Force's total operation and support funding.[18]

In addition to those aircraft, the Air Force has acknowledged that it operates at least one other type of UAS, a stealthy aircraft called the RQ-170. The quantities and characteristics of that system remain classified.

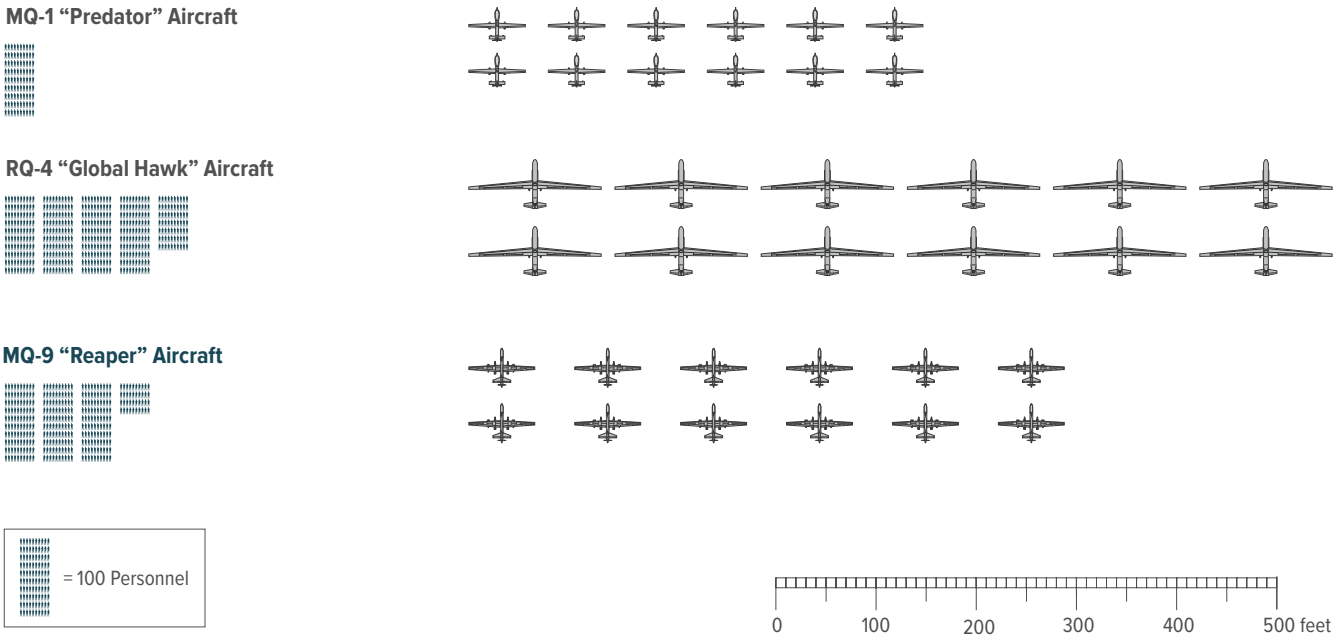
Purpose and Limitations. The Air Force's unmanned aircraft are used primarily for surveillance. In addition, MQ-1s and MQ-9s can be armed with a few missiles or small bombs to conduct limited strike operations. An example of that capability is the United States' well-publicized use of unmanned aircraft to kill suspected terrorists in Pakistan, Yemen, Somalia, and other countries. (Little information about such attacks has been released publicly, but it appears that many of those attacks have been conducted by the Central Intelligence Agency rather than by DoD. Those drones form a separate UAS fleet from the Air Force's and are not covered in this report.)

Today's drones have several advantages: They are generally less expensive to buy than manned aircraft, they can fly very long missions without being limited by the endurance of human aircrews, and they can operate without putting a pilot at risk of injury, capture, or death. Disadvantages of drones include their vulnerability to air defenses and the lack of a human onboard to address split-second issues in ways that might not be possible by a

18. For more information about such systems, see Congressional Budget Office, *Policy Options for Unmanned Aircraft Systems* (June 2011), www.cbo.gov/publication/41448.

Figure 4-5.

Aircraft and Personnel in Notional Air Force Unmanned Air System Squadrons



Source: Congressional Budget Office, using data from the Department of Defense.

All units presented here are notional squadrons of 12 aircraft (actual squadrons vary in size).

remote operator. Not all of those factors are inherent to unmanned systems; rather, they have resulted from the state of available technology and from specific choices about what capabilities the military needed during the past decade and a half—the span over which most of today's drones were purchased.

If desired, it should be possible to design a drone with fewer of those disadvantages. However, improved capability almost always means higher cost. For example, current unmanned aircraft are generally less expensive than manned aircraft largely because their airframes were designed for fairly low-performance, undemanding flight; basically, they need to be able to carry a package of sensors (and, in many cases, a few weapons) to a target area and have enough fuel to loiter there for extended periods. They are not expected to have high speed and maneuverability, to carry heavy payloads, or to operate in defended airspace like many manned combat aircraft—characteristics that can significantly increase costs. Unmanned aircraft with those more advanced capabilities have been proposed, including an unmanned version of a new long-range bomber. But such advanced drones are not expected be low-cost aircraft.

In their current configuration, most of the Air Force's unmanned aircraft are intended to operate mainly in undefended airspace and would generally not be capable of surviving engagements with modern air defenses. Thus, they would have limited utility in a high-intensity conventional conflict; they are most useful in low-intensity and unconventional conflicts, such as the occupations of Iraq and Afghanistan and counterterrorism missions.

According to publicly available accounts, drones have been very effective at attacking small numbers of targets in counterterrorism operations. However, their use by the United States to kill suspected terrorists has generated public controversy (in some cases because drone strikes have killed people other than the intended targets). In particular, the use of unmanned aircraft to attack targets in countries with which the United States is not at war (such as Pakistan) risks generating significant hostility to the United States in those countries. In addition, the strategic utility of targeted killings is not clear—many organizations are resilient enough to quickly replace leaders and other personnel who are killed, so occasionally eliminating members of an organization may not significantly

reduce its long-term effectiveness. At the same time, however, the security measures that many terrorist groups appear to take to avoid drone strikes also degrade the groups' effectiveness in various ways. For example, senior leaders who are in hiding cannot freely direct their subordinates because such communication puts them at risk of being detected and killed.[19]

Past and Planned Use. The United States has had small numbers of unmanned aircraft for many decades, but the widespread deployment of highly capable unmanned air systems is a fairly recent phenomenon. The MQ-1 and RQ-4 were developed in the 1990s and fielded in the 2000s, and the MQ-9 was developed in the 2000s and fielded in the 2010s. Despite their recent introduction, those unmanned aircraft have been used heavily in recent operations, particularly in the war on terrorism and the occupations of Iraq and Afghanistan. Although efforts to arm unmanned surveillance aircraft began before the invasions of Afghanistan and Iraq, the current widespread practice of arming drones to attack ground targets appears to have evolved from their extensive use in those conflicts. Mounting weapons on an unmanned surveillance aircraft has proved to be particularly useful in counterinsurgency and counterterrorism operations because it has enabled DoD to attack small, mobile targets as soon as they are detected and identified without having to summon another aircraft to carry out the attack (such "fleeting" targets would often be lost before the strike aircraft could arrive). For missions requiring substantial firepower, however, the strike capacity offered by today's drones, though useful, is minor compared with that of tactical aircraft or bombers.

For the immediate future, unmanned air systems will probably continue to be particularly useful in two types of situations. First, as part of U.S. counterterrorism operations, DoD is likely to remain responsible for monitoring many different theaters over a very large area for suspected terrorists, insurgents, and militants. Having access to large numbers of relatively low-cost and long-duration aerial sensors, such as those provided by unmanned aircraft, has proved extremely useful in that role. Second, in higher-intensity operations, the Air Force's unmanned aircraft have the potential to increase the rate at which ground targets can be detected and identified. That potential, when combined with the increased capacity to strike targets that has resulted from the widespread adoption of precision-guided munitions (as described at the end of this chapter), could increase the rate at which targets can be destroyed.

For the more distant future, the Air Force is likely to continue pursuing advances in the capabilities of drones, particularly their ability to face the advanced air defenses postulated in some of DoD's planning scenarios. (The Navy is already grappling with that issue as it tries to field a drone that can operate from aircraft carriers. It faces a choice between a relatively inexpensive unmanned aircraft, akin to the Air Force's MQ-9, that is optimized for surveillance and a more advanced system that is capable of penetrating advanced air defenses and conducting both surveillance and strike missions.) Unmanned aircraft may also be considered an option as the Air Force begins to define requirements for its next-generation air superiority aircraft, which is tentatively slated to be fielded in the 2030s.

19. As an example, Mohammed Omar, former leader of the Taliban, was dead for two years before his death became widely known, even to some members of the Taliban itself. Possibly because of the threat of drone strikes, Omar had been secluded from contact with his organization (and the rest of the world) as a security measure. Such extreme seclusion prevents a leader from freely directing and controlling an organization.

Major Element of the Force Structure

Other Department of the Air Force Units and Activities

	Total	Direct	Indirect	Overhead
		Minuteman III Missile Squadron[a]		
Military Personnel per Unit	2,040	690	650	690
Annual Cost per Unit (Millions of 2017 dollars)	380	130	90	160
		RED HORSE Construction Engineers		
Total Military Personnel	19,340	12,780	0 [b]	6,560
Total Annual Cost (Millions of 2017 dollars)	2,170	660	0 [b]	1,520
		Air Force Special-Operations Forces		
Total Military Personnel	24,070	15,900	0 [b]	8,170
Total Annual Cost (Millions of 2017 dollars)	3,730	1,840	0 [b]	1,890
		Rest of the Air Force		
Total Military Personnel	49,010	32,370	0 [b]	16,630
Total Annual Cost (Millions of 2017 dollars)	10,000	6,160	0 [b]	3,840

"Direct" personnel and costs are associated with a major combat unit, "indirect" personnel and costs are associated with units that support the major combat unit, and "overhead" personnel and costs are associated with the major combat unit's share of administrative or overhead activities. For more information, see Chapter 1. The numbers shown here are rounded to the nearest 10 personnel or $10 million; more detailed information is presented in Appendixes A and B.

a. Squadron of 50 Minuteman missiles.

b. In the analytic framework used for this report, other units and activities are generally considered to not have any units supporting them and thus to not have any indirect personnel or costs.

Although the majority of the Air Force's units are connected with aircraft squadrons, the service includes a number of other units with special capabilities that are not directly related to aircraft squadrons. Together, those units account for 21 percent of the Department of the Air Force's operation and support funding.

Minuteman III ballistic missiles armed with nuclear warheads are the Air Force's land-based contribution to the U.S. nuclear deterrent (in addition to the air-based contribution provided by long-range bombers capable of carrying nuclear weapons). Land-based ballistic missiles are generally considered to have the fastest response time of any system for delivering nuclear weapons, and they are deployed in dispersed, hardened silos that would require an adversary to use a relatively large number of nuclear weapons to destroy the entire Minuteman force. Bombers, by contrast, can be vulnerable to air defenses, and ballistic missile submarines can be attacked by ships or other submarines before they launch their missiles or while they are in port.

As with all strategic nuclear forces, the number of Minuteman missiles is generally determined by national nuclear policy and by the outcomes of arms control negotiations rather than by the considerations that typically apply to other military units. Such agreements can affect not only the number of ballistic missiles that the Air Force deploys but also the number of warheads on each Minuteman missile. The United States has an inventory of 450 deployed Minuteman III missiles, but current plans call for reducing that number to 400 by 2018 to comply with the New START treaty.

Air Force **construction engineers**, known as RED HORSE (Rapid Engineer Deployable Heavy Operational Repair Squadron Engineers) squadrons, provide a variety of engineering services to the Air Force. In the past, they have contributed to the success of U.S. military operations in distant theaters by building or improving air bases in places with poor infrastructure and few basing options. Because the United States has often intervened in countries with limited infrastructure—and because the deployment of U.S. forces can place great demands on the ports and air bases that receive them—the ability to improve that infrastructure has typically been highly valuable, despite its relatively low visibility. The majority of RED HORSE personnel are in the Air Force's reserve component.

The Air Force also maintains **special-operations forces**, which are trained, equipped, and overseen by the Department of Defense's Special Operations Command (SOCOM). They focus on such missions as unconventional warfare, special reconnaissance, counterterrorism, and the training of foreign militaries. The forces overseen by SOCOM are discussed in more detail in Chapter 5, which deals with defensewide activities.

By the Congressional Budget Office's estimate, about 49,000 military personnel and $10.0 billion a year are devoted to **units and activities of the Department of the Air Force other than those described in this chapter.** They include a variety of smaller organizations providing capabilities that are neither aircraft squadrons nor organized in support of aircraft squadrons. An important example is the Air Force's space infrastructure, which includes the service's constellations of Global Positioning System communications, weather, and missile-warning satellites. Other examples include the Air Force's contributions to various joint commands and defensewide organizations, as well as some command-and-control and intelligence functions.

Special Topic

The U.S. Military's Strike Capability

Many of the military assets available to the Department of Defense can be thought of as almost generic tools able to attack and destroy a wide variety of enemy targets. That ability, called strike capability, is a marked departure from past practice. Previously, U.S. forces were more specialized in their ability to attack a given type of target, and that specialization often restricted their ability to perform more than a few specific types of missions. Today, the array of systems that exist to identify and destroy targets provides DoD with a unified strike capability that, in most conflicts, is limited more by the ability to gather information about hostile targets than by any other factor.

The full array of U.S. strike assets includes cruise missiles (Air Force and Navy); artillery, rockets, and attack helicopters (Army and Marine Corps); bombers (Air Force); fixed-wing tactical aircraft (Air Force, Navy, and Marine Corps); and armed unmanned air systems (Air Force and Army). To receive information about targets, those assets depend on a vast network of sensors and communications—everything from requests by infantry for fire support to imagery from satellites. The ability to gather information about potential targets and communicate it to versatile strike assets is at the heart of the current U.S. strike system—allowing military commanders to treat a theater of operations as essentially a single list of targets and a single list of assets available to destroy those targets. The two lists can be centrally managed by commanders to match the "supply" of strike assets with the "demand" of targets in a single system that will rapidly destroy all available targets.

The key developments that have produced the modern strike system have narrowed the differences not only between types of strike assets (particularly aircraft) but also between types of targets, thus greatly improving the capability of U.S. forces. As a result, in most recent conflicts, the United States has been able to destroy all known fixed infrastructure targets within the first few days of an operation. Subsequent attacks could then focus almost entirely on supporting ground forces, preventing previously destroyed targets from being rebuilt ("regenerated," in technical parlance), and attacking new targets that were not identified earlier. All of those activities depend crucially on intelligence and surveillance, which is why U.S. strike capability today is often constrained more by the ability to gather intelligence than by the ability to deliver weapons.

Developments That Have Reduced the Differences Between Types of Strike Assets. The evolution of the strike system has been particularly dramatic in the case of aircraft, which provide the majority of U.S. strike capability. Historically, tactical aircraft and bombers faced extreme challenges in attacking targets on the ground. Broadly speaking, they needed to be able to operate in potentially hostile airspace, possibly far from friendly bases; locate targets that might be moving or obscured; and attack them with relatively inaccurate weapons.

Those challenges led to the creation of highly specialized aircraft, capable of performing only a small range of tasks, as well as to highly specialized missions, reflecting the different problems involved in attacking different kinds of ground targets. As a result, there was little commonality between the sort of aircraft that could provide close air support (attacking hostile ground forces that were in contact with friendly ground forces) and the sort of aircraft that could perform strategic bombing (attacking enemy infrastructure or other fixed targets deep within a hostile state).

For example, the A-10 attack aircraft was designed mainly to support U.S. ground forces by destroying enemy armored forces. Originally, its weaponry included antitank guided missiles and armor-penetrating cannons; it depended primarily on the pilot spotting targets visually; its airframe was developed to operate efficiently at relatively low altitudes and speeds; its range was fairly short; and its defenses included armor to protect its pilot from antiaircraft guns. The B-1 bomber, in contrast, was designed mainly to penetrate Soviet airspace in a nuclear attack. Originally, its weaponry included nuclear-armed cruise missiles and bombs; it received information about its targets before takeoff; its airframe was developed for efficient cruising, with limited low-altitude flight; its range was relatively long; and its defenses included complex jamming systems to foil attacks by radar-guided missiles. Neither aircraft could perform the other's role, and the two would be treated very differently in operational usage.

In modern operations, however, both the A-10 and the B-1 can attack and efficiently destroy a wide variety of targets with conventional weapons, and they can substitute for each other in some circumstances. Although the two platforms still differ, with greater strengths in some specific roles, there is now substantial overlap in their capabilities and in the types of missions they can perform. Unlike the previous situation—in which the A-10 fleet would have been irrelevant in a nuclear attack and the B-1 fleet would have been irrelevant in a defense against armored forces—both fleets can be used in most current conventional combat operations. Four primary developments have led to that convergence:

- The U.S. military's recent ability to quickly achieve air supremacy in a conflict, which gives all strike aircraft a much better chance of surviving their missions;
- The widespread use of tankers for aerial refueling, which greatly improves the range of all strike aircraft;
- The development of better methods for spotting targets and communicating information about them, which greatly improves the ability of all strike aircraft to find their targets; and
- The development of relatively affordable and accurate precision munitions, which greatly improves the ability of all strike aircraft to actually destroy their targets.

Today, the major differences between the strike capabilities of most U.S. combat aircraft relate to their electronics and software rather than to traditional design factors such as range, speed, or payload capacity. Effective strike missions require aircraft that are capable of accepting up-to-date information about a target from a wide range of sources, carrying the most modern munitions, and communicating targeting information to those munitions. Such aircraft, if properly supported, can effectively attack almost any ground target in a modern conflict.

Although the developments listed above have had the greatest consequences for aircraft, most of them have affected other strike assets as well. For instance, the Army's and Marine Corps' attack helicopters have benefitted from almost all of those developments in much the same way that fixed-wing aircraft have. In addition, the Army's artillery is vastly more capable when equipped with affordable and accurate munitions that are provided with high-quality targeting data.

DoD and many outside observers have cautioned that the freedom U.S. forces have had to strike targets in recent conflicts might not exist in future conflicts against more competent or well-armed opponents. The effectiveness of the U.S. strike system depends on several factors that opponents could disrupt. As examples, an effective method of jamming Global Positioning System (GPS) signals could degrade the effectiveness of U.S. munitions, and the loss of air superiority could imperil strike aircraft and greatly limit the use of aerial refueling.

Developments That Have Reduced the Differences Between Types of Targets. Before the creation of cheaper and more accurate munitions that could receive targeting information from many sources, the limitations of sensors and weapons meant that attacking different types of targets required very different approaches. Whether a target was mobile or stationary, situated close to friendly forces or not, and heavily armored or not were all crucial factors in determining how challenging the target would be to destroy and how it would be attacked.

Traditional unguided bombs (now often referred to as "dumb" bombs) were notoriously difficult to hit targets with. As a result, attacking a fixed target generally required having several aircraft drop large loads of bombs to increase the chances of a close hit—and even then, multiple attacks were frequently necessary before a target was destroyed. Mobile targets were often impossible to destroy with any certainty in such a manner, armored targets (even when stationary) could not reliably be hit closely enough to penetrate their armor, and the inaccuracy of weapons led to sharp restrictions on using them in proximity to friendly ground forces and noncombatants. Previous U.S. efforts to improve munitions frequently focused on developing specialized warheads and sensors that could attack a specific type of target more effectively, but in many cases they were too expensive to field in large numbers.

Many modern precision munitions incorporate specialized sensors, such as radar or infrared guidance systems, but they are notable for their heavy reliance on GPS guidance sets, which are cheaper than other types of guidance systems. By itself, GPS guidance is usually accurate enough for attacks on stationary targets, and munitions with other sensors are usually accurate enough for attacks

on mobile targets.[20] Crucially, the ability to accept GPS targeting data from other sources means that any strike asset equipped with such munitions, connected to communications networks, and able to pass target coordinates to the munitions can effectively attack the target. For example, a U.S. bomber pilot need not see enemy infantry in contact with U.S. ground forces to engage that enemy; instead, the bomber can receive targeting data from the U.S. ground forces and attack the target they have identified.

When provided with accurate targeting data, such modern munitions are precise enough that a single bomb has a good chance of destroying most types of ground targets. That ability in turn allows a single aircraft to destroy many targets, rather than requiring several aircraft to destroy a single target—an enormous increase in U.S. strike capability.

20. GPS guidance tends to be equally effective regardless of the type of target being attacked because munitions equipped with that guidance move toward a specific set of physical coordinates; if the target is at those coordinates, the munition will generally strike it.