Chapter Eleven

ILLUSTRATIVE MILITARY VALUE

Previous chapters have highlighted specific interoperability issues based on reviews of past coalition operations and analyses of planning processes and programmatic initiatives that are of prime interest to the Air Force. In this chapter, we examine the implications of these interoperability issues in an end-to-end manner by analyzing representative military operations.[1]

Specifically, we analyze air surveillance during peacekeeping operations, force protection against conventional aircraft and cruise missiles using DCA capabilities, and interdiction of moving columns of armor during the halt phase of an MTW. For each of these operations, we describe an operational concept, identify the system capabilities of the NATO-ally participants, and highlight actual and potential contributions of allied forces in U.S.-allied coalition operations.

PEACEKEEPING OPERATIONS

In examining the contribution of allies to military coalitions and the benefits of interoperability, the lower end of the spectrum of conflict—peacekeeping operations—must be considered. Because of the lesser strategic risk and value of these operations to the United States, burden sharing becomes an important issue. As illustrated in

[1]To fully measure the military value of interoperability of the United States and its NATO allies in coalition operations, analysis of additional military missions across the spectrum of conflict is needed.

Figure 11.1, we often think in terms of U.S. contributions without due consideration to the contribution of allies.

Allies provide important capabilities that can reduce the burden or fill in for potential shortfalls in U.S. capabilities. Enhancing the interoperability of U.S. and allied systems would increase their ability to do so. In peacekeeping operations, for example, NATO, French, and U.K. AWACS can be used instead of high-demand, low-density U.S. AWACS to provide early warning and air surveillance.[2] A simple calculation indicates that the combined NATO, French, and U.K. AWACS fleets can support about four continuous orbits while the

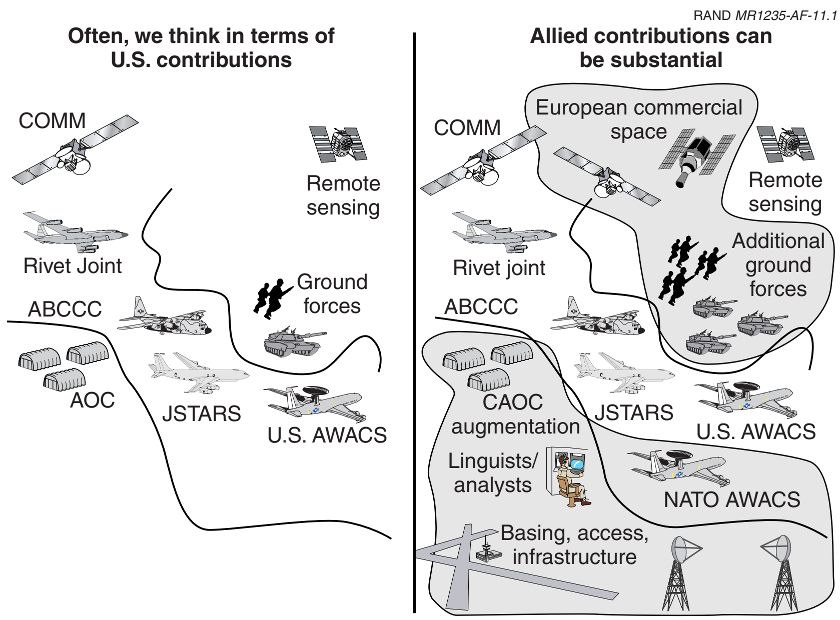


Figure 11.1—Allied Contributions Are Important in Peacekeeping Operations

[2]High-demand, low-density aircraft are aircraft that are heavily tasked in support of ongoing operations, but because they are relatively few in number, it is difficult to satisfy the demand.

United States can support about five continuous orbits.[3] This practice proved important during Operation Allied Force, when 87 percent of AWACS sorties were flown by non-U.S. AWACS. U.S. AWACS not only supported Allied Force but were also needed to support SWA and Korean operations and exercises.

NATO partners also provide substantial contribution to CAOCs, including expert personnel who fill key positions and perform critical functions. For example, in Operation Allied Force, allied personnel assumed the battle staff director's position as part of the watch rotation. Allied personnel also manned key CAOC combat plans positions.

U.S. NATO allies can often provide good-quality human intelligence because they are more familiar with countries and regions in which peacekeeping operations have recently taken place. Such a contribution is important in the full range of C3ISR functions, from indications and warning to intelligence preparation of the battlefield to combat assessment.

Allies can also provide space-derived information and services from commercial and government assets. SPOT imagery was used in Operations Desert Shield and Desert Storm and continues to be used in Balkan operations. In fact, the United States purchased a ground terminal to receive SPOT imagery and exploited such imagery to support rehearsal of aircraft missions. Also, imagery from commercial sources was merged with U.S. national imagery to produce a Controlled Image Base product that supported fighter squadrons in the planning of missions in Operation Allied Force.[4]

In addition to air surveillance assets and infrastructure support, perhaps the most important contribution of allies to peacekeeping operations has been in the area of ground troops. In the fall of 1999, for example, NATO allies provided about 85 percent of the 55,000 NATO

---

[3]NATO has 17 AWACS, the U.K. has declared six AWACS for NATO use, and the French have four AWACS, for a total of 27 aircraft. If 75 percent are coded as combat support (i.e., 20 aircraft) and if five aircraft are needed to maintain a continuous orbit, then four orbits can be supported. The United States has 32 AWACS, with 24 coded for combat support; thus, the United States can support about five continuous orbits.

[4]See ERIM International, Inc. (2000), and Electronic Systems Center (2000).

troops serving in the Kosovo peacekeeping operation (Operation Joint Guardian).

FORCE PROTECTION

One primary mission of the U.S. Air Force is to achieve and maintain air superiority/supremacy by conducting OCA and DCA operations, with an emphasis on OCA operations.

Conducted to attack the enemy's ability to wage an air war, OCA operations include attacks on the enemy's ground infrastructure (e.g., runways, control towers, fuel storage tanks, aircraft on the ground), as well as air-superiority sweep operations that seek out and destroy enemy aircraft over enemy territory. DCA operations counter the enemy's offensive air power and are normally conducted over friendly territory to protect friendly assets. DCA is viewed as an important counterair mission, but it can be less effective than OCA because it is reactive to the enemy's initiative.[5]

Until recently, the air threats have been primarily conventional aircraft (fighters, bombers, and helicopters) and, except for concerns regarding combat identification, U.S. air forces have been well equipped and well trained to conduct effective OCA and DCA operations. In contrast, NATO and its member nations, with their emphasis on Article 5 operations (homeland defense), have developed substantial capabilities to conduct DCA operations against such threats.[6]

However, the proliferation of theater ballistic missiles (TBMs) and, in the future, cruise missiles (CMs) pose significant new security challenges to the United States and to its allies, especially if such missiles are designed with stealth technology or armed with chemical, biological, and nuclear WMD. The United States is active in nonproliferation efforts and is also developing counterproliferation

---

[5]U.S. air-superiority fighters also conduct "force protection" operations that are designed to protect primary mission aircraft (e.g., ground attack, airlift, and surveillance aircraft) from enemy air attacks. An example of such an operation is fighter escort. In this section, we will focus on DCA operations because of commonalties with NATO capabilities.

[6]They also have well-practiced OCA capabilities against ground aircraft support facilities (e.g., airfields, runways, and fuel and repair facilities), but these are not optimal against modern air defenses.

capabilities such as TAMD. These efforts are meant to deny military benefits to potential adversaries who might develop TBM/CM/WMD capabilities to counter the U.S. ability to conduct military power projection operations.

U.S. military power projection operations often involve (1) forward basing, operational deployments, and the prepositioning of equipment, (2) rapid deployment of decisive force to theater, and (3) precision strike to swiftly meet the defined warfighting objectives and to minimize casualties and collateral damage. Future TBM/CM/WMD threats may counter these tenets of U.S. warfighting strategy by (1) rendering forward forces and equipment vulnerable to attack, (2) slowing and complicating access to ports and bases (politically as well as operationally), (3) creating response dilemmas in the face of casualties, and (4) disrupting and lengthening the conflict. Their ultimate goal is to deny the United States the ability to attain its warfighting objectives and to force the United States to settle for a less desirable outcome. To the extent that NATO adopts, develops, and employs its own military power projection capabilities, NATO forces will also be vulnerable to these future TBM/CM/WMD threats unless it develops its own TAMD capabilities, possibly by leveraging capabilities now being developed by the United States.

In this section, we will explore the capabilities of U.S. and NATO allies' air forces to defend against conventional aircraft (fighters, bombers, and helicopters), CMs, and TBMs to support the collective mission of force protection.

Against Conventional Aircraft

OCA has been the dominant counterair component used by the U.S. Air Force (e.g., in recent operations such as Desert Storm) to defend against aircraft threats. Today, the Air Force's primary air-superiority fighter is the F-15C, a high-performance, supersonic, all-weather aircraft. In the future, F-22s will conduct air-superiority OCA operations by attacking enemy aircraft over enemy territory with and without air surveillance support from AWACS. At the same time, flights of F-15Cs, F-16s, and JSFs, usually with AWACS support, will conduct OCA and DCA operations. The introduction of the F-22, with its advanced sensors and ability to operate in enemy airspace, has the potential to significantly enhance the situational awareness of less capable air-to-air assets. However, there is no process for disseminating data collected by F-22s to other interested parties (e.g., AWACS, F-15Cs, F-16s, and control and reporting centers and elements [CRCs/CREs]) outside of the flight. Even so, the Air Force's ability to conduct air-to-air OCA and DCA operations against conventional aircraft remains unmatched.

Our NATO allies have a substantial number of air-superiority fighters; however, they were not designed to operate autonomously and primarily perform DCA operations. With NATO's past emphasis on homeland defense and with each nation's concern with air sovereignty, air-superiority fighters performed DCA operations with C2 functions provided by ground control sites located within and operated by each nation. Although the NATO AWACS had limited capability to perform the control function, the aircraft was used primarily to augment the ground-based radar surveillance systems by providing early warning against air threats, especially those at low level.

Our NATO allies are in the process of improving their ability to conduct DCA and OCA operations. They are developing their next-generation air-superiority fighters (EF-2000, Rafale). The NATO AWACS modernization program is in the process of adding consoles for more onboard weapons controllers—this is particularly critical for out-of-area operations where ground control sites either are nonexistent or are not optimally located to perform the control function—and the NAEWFC is improving its training program to ensure that NATO AWACS aircrews are properly trained to perform the control function. The United States and four of its major NATO allies (France, Germany, Italy, and Spain) are developing the MIDS terminal for installation on fighter aircraft, which will allow for encrypted, jam-resistant digital voice/data communications with U.S. and NATO AWACS, both of which are equipped with JTIDS Class 2H terminals. Following the completion of these modernization programs, the capabilities of NATO AWACS and NATO partner air forces to conduct DCA operations against conventional aircraft threats should be close to U.S. capabilities and more than adequate to cope with the threat posed by likely adversaries.

Against Cruise Missiles

While OCA remains the dominant U.S. Air Force counterair component against conventional aircraft, the emergence of proliferated CM threats, particularly if they are somewhat stealthy or armed with WMD, will likely require a layered defense. The implication for the Air Force and U.S. NATO allies is that enhanced barrier DCA operations will be needed to intercept threats not neutralized by OCA operations.

Barrier DCA operations involve establishing a number of AWACS orbits along the entire threat corridor/border, with each AWACS controlling a number of air-superiority fighters on combat air patrol (CAP). The number of AWACS orbits needed is determined by the length of the threat corridor, the coverage area of the AWACS surveillance radar, the amount of coverage overlap assumed between neighboring AWACS orbits, and the number and performance of the fighter aircraft.

The coverage area of the AWACS radar is dependent on the signature, or RCS, of the threat, with lower-RCS targets yielding smaller coverage areas. Near-term CM threats may be somewhat stealthy with nose/tail signature suppression, whereas more advanced threats may involve all-aspect signature suppression. CMs with nose/tail signature suppression are nominally less of a challenge because their side-aspect signature is similar to that of nonstealthy fighters and can be detected at long ranges unless the CMs approach the AWACS directly, which is unlikely without a well-coordinated attack.[7] CM threats with all-aspect signature suppression require either more AWACS orbits because of their reduced coverage area against the CM or an improvement in the AWACS surveillance radar.

As discussed in Chapter Seven, RSIP is a major AWACS system upgrade that greatly enhances the operational capability of the surveillance radar, especially against lower-signature airborne targets such as CMs. The RSIP capability will provide significant improvement over the current U.S. AWACS radar, reportedly a factor-of-two

---

[7]Even in a well-coordinated CM attack, if air-superiority fighters are forward deployed, they can conduct sweep operations to detect and engage CMs from a side aspect.

improvement in detection range.[8] At the end of January 2000, all NATO AWACS were upgraded with RSIP capabilities; U.S. AWACS are scheduled to complete these upgrades during FY 2005–2006.

We used the following operational concept to assess barrier DCA operations against CMs. Flights of fighters would act autonomously from the AWACS, detecting and engaging approaching CMs. Information about successful engagements as well as about CMs that penetrate the fighter barrier would be passed to the AWACS so that it can direct fighters on CAP to intercept and kill the leakers. The F-22, with its advanced sensor capabilities, has the potential to fill this role; as mentioned earlier, however, it is currently limited in sharing information with other air defense elements. Also, because the F-22 is not designed to operate with EF-2000 and Rafale, it is unlikely that there will be a mix of these fighter types within the specified engagement zone. However, a U.S. and NATO CONOPS to employ air-superiority fighters in such a DCA role needs to be developed.

The AWACS, using either Link 16 (JTIDS/MIDS terminals) or voice communications, will control several flights of U.S. and/or NATO allies' air-superiority fighters (e.g., F-15Cs, F-16s, JSFs, EF-2000s, and Rafales) within its coverage zone and will direct them to intercept approaching CMs. Good situational awareness such as that provided via Link 16 network is essential to the efficient allocation of shooters to targets, airspace control, and adequate deconfliction as well as to minimizing the risk of Blue-on-Blue engagements in such operations. Again, information about successful engagements and about cruise missiles that penetrate the DCA barrier will be passed to any middle and terminal area air defenses (primarily Army and Navy assets).

Because there will be coverage overlap by neighboring AWACS, sensor netting may be needed to avoid dual tracks or loss of track on low-signature targets; further analysis is needed to determine if Link 16 is sufficient or if CEC constructs are more appropriate. If CEC is required—in this example or in other cases in which sensor netting becomes necessary (see below)—and the United States integrates CEC capabilities on its AWACS and NATO does not (as discussed in

[8]See Air Combat Command (1996), p. 82.

Chapter Seven), the two fleets will become less interoperable. At best, NATO AWACS could inject near-real-time Link 16 track data rather than raw sensor data into the real-time CEC network, assuming a Link 16–CEC interface is developed.

In addition to the front-line barrier DCA operations, the United States is looking to netted joint-service area air defenses (e.g., Patriot, Aegis) to constitute the middle layer, and terminal area air defenses (e.g., the Close-In Weapon System [CIWS]) to constitute the final layer of a defense-in-depth concept for addressing CM threats. These defense-in-depth operations may be conducted in joint air defense operations/joint engagement zones (JADO/JEZ), requiring close coordination between ground- and ship-based defenses and aircraft to maximize effectiveness and minimize fratricide.

A SIAP that is well integrated with appropriate theater near-real-time tactical intelligence broadcast feeds is essential to help identify, track, and engage threats while minimizing the probability of fratricide. A potential SIAP enabler is the joint composite tracking network (JCTN), a real-time sensor fusion system that enables ship, aircraft, and ground air defense systems to exchange sensor measurement data to create common composite air tracks of fire control system accuracy.

Although the JCTN has yet to be defined, CEC-like constructs are a current model. Also, as mentioned above, interfaces between JCTN- and non-JCTN-equipped participants (e.g., those using a joint data network [JDN] such as Link 16) have yet to be defined. Again, if the United States integrates CEC capabilities or another JCTN system on its AWACS to support such defense-in-depth concepts and NATO does not, the two fleets will become less interoperable.

Against Theater Ballistic Missiles

As for CM threats, U.S. operational architectures to address TBM threats are typically based on defense-in-depth concepts[9] and can be

---

[9]In this discussion on force protection, we separated the CM threat and the TBM threat. In actuality, the United States is developing TAMD architectures and operational concepts to address CM and TBM threats together (note that there is usually little discussion of conventional aircraft threats, presumably because the

viewed as consisting of four components: (1) active defenses—terminal defenses (e.g., Patriot PAC-3), midcourse defenses (e.g., Theater High-Altitude Area Defense [THAAD] or Navy Theater-Wide), and boost-phase or ascent-phase defenses (e.g., airborne laser [ABL] or Airborne Interceptor [ABI]); (2) counterforce—air-to-ground systems (e.g., fighters and attack helicopters) and ground-to-ground systems (e.g., Army Tactical Missile System [ATACMS]); (3) passive defenses (e.g., hardened aircraft shelters and revetments, suits and masks to protect against the use of chemical and biological agents, mobility, and camouflage, concealment, and deception [CC&D] techniques); and (4) battle management/command, control, communications, computers, intelligence, surveillance, and reconnaissance (BM/C4ISR) to tie these Army, Navy, and Air Force elements into an effective, integrated, joint-service "system of systems" operational concept.

Other than passive defenses, NATO allies do not have similar capabilities to address TBM threats.[10] NATO can choose to develop such capabilities; however, the TAMD programs listed above—especially the active defenses—represent a substantial investment by the United States, and it is to NATO's advantage to leverage the capabilities now being developed by the United States to the extent that the United States will permit it.[11]

INTERDICTION DURING THE HALT PHASE OF A MAJOR THEATER WAR

Halt is a mission element within the broad set of air-to-ground interdiction operations (sometimes referred to as battlefield air interdiction [BAI]). The halt phase is particularly challenging because the targets are mobile, hard to kill, and defended by fixed and mobile SAMs and antiaircraft artillery (AAA). Halt analyses highlight a potentially significant divergence between the doctrine, tactics, and ca-

---

United States can successfully engage such threats and thus they are implicitly addressed in TAMD concepts).

[10]The Patriot systems owned by Germany and the Netherlands could be upgraded to the Patriot Advanced Capability-3 (PAC-3) capability, which would provide some defense against TBMs.

[11]Similar observations are made in Gompert et al. (1999).

pabilities of the United States and those of the other NATO nations. Halt brings together several issues, including ground surveillance (e.g., U.S. JSTARS, NATO AGS, or other European nations' airborne surveillance capabilities), dynamic battle management (e.g., airborne versus ground-based), the availability of digital data links (e.g., JTIDS/MIDS terminals), and the employment of standoff precision strike with smart, lethal weapons, especially those carrying antiarmor submunitions.

This discussion focuses first on engagement-level operational concepts and systems needed to interdict moving armor. We then investigate the military value of U.S. and allied air power interoperability in interdiction operations within the larger context of the early halt phase of an air campaign.

Engagement-Level Considerations

The emergence of more mobile ground forces and more capable air defenses, and the desire to improve efficiency (more kills per sortie) and minimize collateral damage in interdiction operations, are forcing changes in the way interdiction operations will be conducted in the future. In particular, there is a need for new weapon systems and new operational concepts. This section discusses these issues as a necessary prelude to our analysis in the next section of the military value of U.S. and allied air power interoperability in interdiction operations within the larger context of the early halt phase of an air campaign.

Challenging Targets and Threats. Traditionally, most air-to-ground missions have been planned one or two days in advance and executed through the ATO. The strike aircraft would use their onboard sensors to acquire the targets and then release unguided or guided direct attack munitions. This is adequate against strategic targets and fixed interdiction targets such as garrisons or lines of communication (LOCs) but is not an effective or efficient method for attacking short-dwell or moving targets. Often, moving targets were targets of opportunity and, if found by the strike aircraft, would be attacked instead of, or in addition to, the fixed targets the aircraft were directed to strike. If aircraft were directed to find and attack moving targets, especially with limited advance knowledge, the operation would devolve to an "armed reconnaissance" operation that may be effective if targets were found and engaged but ineffective and inefficient if targets were not found.

Short-dwell and moving targets are assuming greater importance. For example, rapidly finding and attacking "target-rich" arrays such as advancing armor columns in a halt operation or "sparse targets" such as C2 vehicles, advanced SAMs, or TBM transporter-erector-launchers (TELs) are important future challenges for the U.S. Air Force.

Unfortunately, other adverse threat trends, particularly mobile long-range air defense systems (e.g., SA-10s, SA-12s) and mobile forward-area terminal air defenses (e.g., 2S6 vehicles, shoulder-fired infrared SAMs) further complicate matters. These defenses are difficult to suppress and, because of their lethality, limit the effective employment (i.e., with low attrition) of direct-attack precision weapons. Terminal defenses may force aircraft to higher altitudes where weapon performance may be degraded. Long-range defenses may force aircraft to employ standoff weapons. In addition, if an armed reconnaissance approach is used to find and engage moving targets, the exposure of such aircraft to these advanced air defenses will be increased with a proportional increase in risk to the aircraft.

System Improvements. To address enhanced air defenses and mobile target sets, efforts have been under way in the United States for some time to develop high-altitude delivered, direct-attack precision weapons (e.g., WCMD) and effective standoff precision weapons (e.g., JSOW)—particularly variants capable of hitting and killing armored vehicles (e.g., WCMD and JSOW carrying BLU-108 submunitions). WCMD and JSOW variants carrying combined-effects bomblets (CEBs) designed for soft-area targets can be used against the softer (i.e., nonarmor) elements of an armor column, such as trucks, mobile command posts, and air defense units. Note that the emphasis on developing standoff precision weapons is intended not only to ensure safe (minimum risk of aircraft attrition) and efficient (high kills per sortie) prosecution of targets (whether fixed or mobile) but also to minimize collateral damage, given that the rules of engagement have become increasingly stringent.

In addition to its investments in standoff precision weapons, the United States is making investments in offboard targeting assets (e.g., JSTARS improvements such as RTIP, enhanced tracking algorithms, and implementation of JTIDS attack support messages) to support shooters with timely moving-target information. Although standoff is generally a useful weapon characteristic, most current long-range weapons can be difficult to employ effectively against moving targets because they cannot be updated in flight. Specifically, if the targets change direction or speed unexpectedly, the targeting solutions provided by the offboard sensor may be in error, and the weapons may not be delivered to the right locations.

Our NATO partners are not making comparable investments in offboard targeting assets and standoff precision-guided weapons (as discussed in Chapters Eight and Ten, respectively) and instead rely on their SEAD capabilities and shooter self-protection capabilities to allow for the employment of direct-attack weapons. Thus, U.S. efforts in attacking ground targets, particularly nonemitting mobile targets, are substantially ahead of those of its NATO partners.

Emerging Operational Concepts. In addition to the development of specific systems, effective future air-to-ground operations against moving targets (e.g., armored fighting vehicles [AFVs]) will require substantial development of operational concepts and associated tactics and doctrine. As U.S. AWACS is to air-to-air missions, JSTARS is potentially to air-to-ground missions; thus, it is natural to investigate the central role JSTARS, a future NATO AGS system, or the U.K.'s ASTOR might play in interdiction missions. Equipped with wide-area-coverage GMTI radars, these systems can bring to NATO and coalition operations a new capability for detecting moving ground targets and—with planned enhancements such as an upgraded radar and an improved tracking algorithm—the opportunity to develop targeting, control, and BM capabilities for air-to-ground missions.

A notional operational concept for interdicting columns of moving armor is depicted in Figure 11.2. The concept begins with target detection (and classification, where feasible), in this case by JSTARS. Then, JSTARS operators track the threat arrays and develop and provide targeting information to coalition fighters, assumed to be on CAP in the general area. In parallel, JSTARS controllers, in contact with the fighters, provide the battle staff on JSTARS with force status information to coordinate attack plans and provide the fighters with

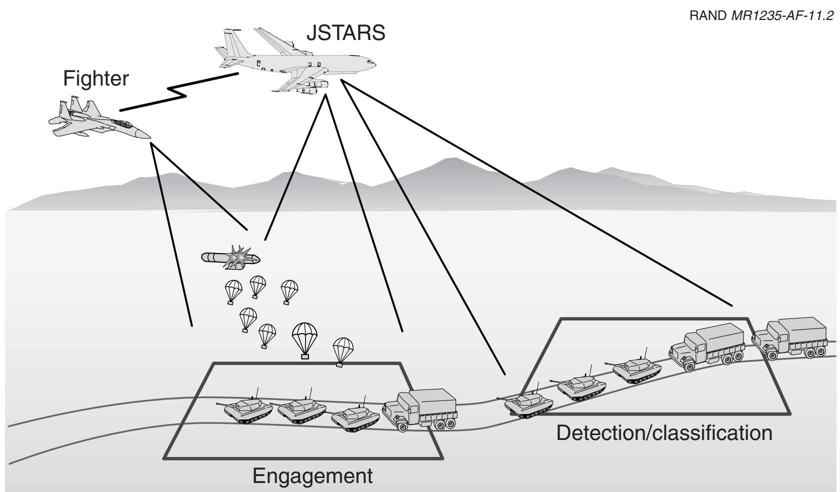


Figure 11.2—Operational Concept for Interdiction of Moving Armor

the necessary situational awareness to ensure their safety and effectiveness. Communications with the fighters will be done by voice and by digital data link (e.g., JTIDS/MIDS terminals).[12]

Finally, U.S. fighters will release their standoff weapons (e.g., JSOW) or high-altitude delivered munitions (e.g., WCMD) to achieve the planned time-on-target against the predicted aim points, accounting for uncertainties in the last sensor update, anticipated target motion, transmission of target data,[13] downloading the data into the weapons, and weapon time-of-flight delays. In this form of targeting,

[12]Because of the current debate on the future NATO AGS discussed in Chapter Eight, we recommend that future research examine an alternative CONOPS for interdiction missions in future coalition operations. This CONOPS would consist of a variety of GMTI sensor platforms providing GMTI data to ground nodes where personnel would analyze the data and provide targeting information and direction to fighters.

[13]Target data provided to the pilots by JSTARS include accurate aimpoint geocoordinates, weapon-approach azimuth for effective munitions dispensing, and desired time-on-target.

U.S. fighters do not have to acquire the targets with their onboard sensors.[14]

As depicted in Figure 11.2, armored vehicles often travel in columns on roads. In open terrain, however, the armored vehicles could travel off-road, thereby complicating the targeting solution by making direction of movement more difficult to predict. Also, for long-time-of-flight weapons, the predicted aim point is more uncertain. In both cases, uncertainties in the targeting solution can result in reduced effectiveness for weapons with small footprints or when attacking targets moving in short columns.[15]

Because the allies' fighters employ relatively low-altitude direct attack weapons (e.g., Mavericks), JSTARS provides less targeting support than it does to fighters employing standoff weapons. JSTARS can be used to deconflict fighter attacks by directing them to different columns or different segments of long columns. The fighters can then acquire and target the moving targets using onboard sensors. Thus, the targeting solution is not affected by target motion to the degree it is for standoff weapons using offboard-generated data. However, the fighter is at much greater risk to terminal air defenses.

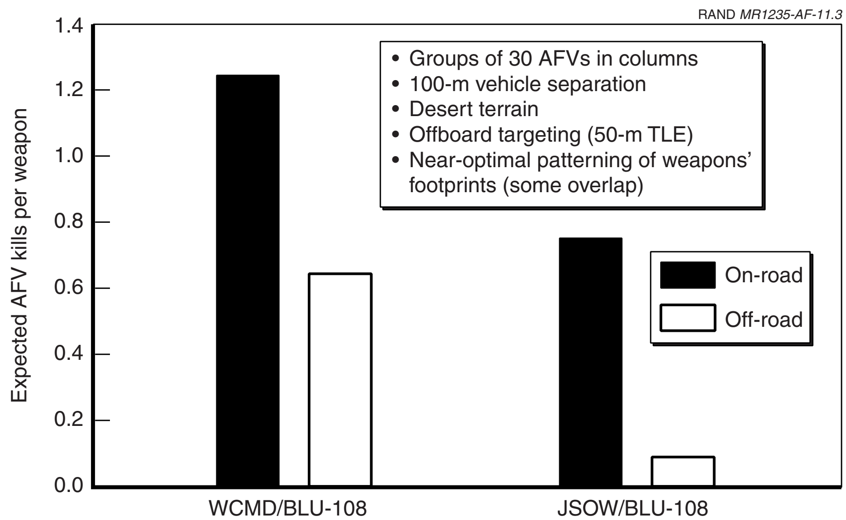
Weapon Effectiveness Using Offboard Targeting Data. As stated above, the effectiveness of weapons targeted against moving targets using offboard data are sensitive to time delays (i.e., weapon time of flight, ISR and C2 delays in relaying targeting solution to shooters), target characteristics (e.g., spacing of vehicles, on-road versus off-road movement), and uncertainties in surveillance sensor measurements (current target position and velocity). Figure 11.3 illustrates the sensitivity to on-road versus off-road movement and weapon time-of-flight.[16] The figure shows the armor killing effectiveness in terms of expected kills per weapon for WCMD and JSOW, each deliv-

---

[14]As discussed earlier, the acquisition of moving targets with onboard sensors is still a predominant practice in interdiction operations conducted today.

[15]If there are a large number of targets in a long column traveling along the road, an accurate targeting solution is not critical, as the weapons can be patterned along the road (with some overlap of footprints). The lead and trailing elements may not be attacked because of errors in the targeting solution, but the middle elements will be.

[16]Data for this figure were obtained from two recent RAND studies: Ochmanek et al. (1998) and Rhodes and Harshberger (1998).



SOURCES: Ochmanek et al. (1998), Rhodes and Harshberger (1998).

Figure 11.3—Weapon Effectiveness Using Offboard Targeting Data

ering antiarmor submunitions (e.g., BLU-108s) from high altitude against columns of AFVs advancing either on-road or off-road. In the on-road case, we assume that accurate road maps are available and that the columns do not change their direction of movement when they encounter road intersections.

Whether the targets are on-road or off-road, WCMD is more effective than JSOW because it dispenses ten BLU-108 submunitions, whereas JSOW dispenses only six over a similar-size footprint. Because JSOW has a longer time-of-flight than WCMD, its effectiveness is more sensitive to off-road movement by the armor columns—to an extent that employment of JSOW may not be practical. An operational solution is to emphasize SEAD missions so that standoff weapons are not required. Another option is to improve standoff weapons—e.g., by providing them with the capability to receive in-flight target updates, increasing their submunitions' footprints and adding improved seekers, or developing submunition delivery vehicles equipped with a smart seeker to locate target clusters before releasing submunitions.[17]

We did not assess the weapon effectiveness of the WCMD and JSOW carrying CEBs against trucks and other soft targets in the armor columns because we explicitly modeled attacks only against AFVs in our mission-level analysis. However, we did assume that the weapon effectiveness against these soft targets is at least as good as if not better than that depicted in Figure 11.3. As a consequence, our daily JSOW and WCMD allocations (50 percent to BLU-108 variants and 50 percent to CEB variants) were made in proportion to the composition of the armor columns (50 percent armor targets and 50 percent nonarmor targets).

Offboard targeting data are not used to support the employment of low-altitude direct attack weapons; the targeting solution is developed by the fighter and its onboard sensors. In the case of Maverick, the seeker on the weapon itself locks onto the target before the fighter releases the weapon. For our analysis, we used a single-shot probability of kill of 0.5 against AFVs;[18] the same value was used for both allied and U.S. fighter employment of direct attack weapons.

When used in our mission-level analysis, the kill probabilities above are adjusted to account for a number of operational degrades. Sorties will be aborted because of bad weather, they will be provided with inaccurate information, or they will be mistakenly directed to targets that do not match the weapons being delivered. Over time, as the target set is attacked and destroyed, it will be more difficult to distinguish unattacked targets from those that have been damaged and the columns will not be as uniform or dense, with a resulting decrease in weapon kill efficiency for weapons dispensing submunitions over a given footprint. Because we use a leading-edge attack strategy to counter the enemy force's penetration into friendly territory, there is a greater likelihood that unattacked targets will be among damaged targets, which will confuse the sensors on the BLU-108 submunitions and result in further degrades to overall kill probabilities.

---

[17]The U.S. Air Force initiative to develop a Low-Cost Anti-Armor System (LOCAAS) is pursuing this last alternative.

[18]See Ochmanek et al. (1998).

Mission-Level Analysis

The discussion above focused on engagement-level operational concepts and systems needed to conduct an interdiction mission against moving armor. In this section, we investigate the military value of U.S. and allied air power interoperability in interdiction operations within the larger context of the early halt phase of an air campaign supporting a notional out-of-area operation in open, desert terrain, such as in SWA, during the 2010 time frame.

The analysis will highlight a diverse set of interoperability issues—ones that span strategic (e.g., deployment and basing) as well as tactical (e.g., weapons and delivery tactics) levels.

Measure of Effectiveness. The number of AFVs is widely used in the U.S. defense community as a measure of a ground force's combat potential. Hence, the yardstick used here to measure the relative importance of selected interoperability issues is the number of days needed to halt an invading army,[19] where the "halt" is defined as that time when a specific fraction of AFVs are stopped.[20] This fraction varies but is typically on the order of 50 percent. We used 50 percent.

There is also value in attacking softer targets such as mobile command posts (if they can be identified) to degrade the enemy's command and control of the invading army and trucks that carry personnel, spare parts, fuel, and other consumables vital to the invading army. However, the connection between damage to these support assets and the invading force's combat capabilities is difficult to assess. Nevertheless, we chose to attack these softer targets with CEB variants of JSOW and WCMD because we believe that it is part of a valid attack strategy under the conditions postulated in this analysis. This attack strategy will consume resources (i.e., sorties will be allocated to these targets), and because we did not include any measur-

---

[19]Halt time can be related to the maximum distance traveled by the invading army. For comparative purposes this distance can be correlated to critical potential objectives, e.g., the enemy force's reaching a key city such as Dhahran in Saudi Arabia. Thus, maximum penetration distance is another metric besides halt time to demonstrate the importance of quickly stopping the enemy's advance. We did not use this metric in our analysis.

[20]Stopped AFVs include AFVs killed but also include other elements remaining in a unit that is considered no longer militarily effective.

able value to these attacks in halting the armor columns, the results of our interdiction analysis should be considered conservative.

Similarly, there is often merit in attacking LOCs (such as bridges and other choke points) to slow or stop the advance of an invading army. But the value of such attacks can be difficult to assess, and depends, for example, on the number of alternative roads, the amount of open terrain, and the enemy's ability to quickly repair any damage. In our analysis, we did not include any value to attacking LOCs because we assumed open, desert terrain and the availability of alternative avenues of approach.

Notional Threat Disposition. We consider a five-division enemy ground force of heavy armor advancing on two axes, in a two-column formation on each axis.[21] Vehicles are spaced approximately 100 meters apart, with a nominal advance speed of 60 km per day, although this will vary depending on circumstances. Organic to these divisions are a variety of systems, including tanks, infantry fighting vehicles (IFVs), artillery, air defenses, helicopters, and trucks. The total may number approximately 1000–1200 individual systems per division. Of that total, about 600 systems (i.e., about 50 percent of the systems) are AFVs (tanks and IFVs). We explicitly model only the length of time required to stop the AFVs; however, our weapon employment strategy includes delivery of munitions that are effective against both armor and nonarmor targets.

As noted, there are air defenses organic to the advancing columns that pose a threat to the attacking air forces. These defenses are expected to include the Russian-built 2S6 (radar-directed AAA and SAM combination), the SA-15 (radar-directed SAM), and the SA-18 (infrared-guided SAM). In addition, in some cases the formidable SA-12 may be present. If so, we postulate that this SAM would most likely advance with the enemy columns in a leapfrog deployment, possibly some distance back from the main columns at any given time but still capable of significant forward "reach" because of its very long range. Although we did not quantitatively examine the

---

[21]Although the enemy may have ten divisions for an invasion, we envision a short-warning scenario in which five divisions are appropriately positioned and postured at the start of hostilities.

impact of the SA-12's presence, we discuss its impact in qualitative terms.

Relative Contribution of Forces. Earlier chapters provided a perspective on the NATO allies' air power contributions to recent conflicts and highlighted the fact that their contributions of fighter aircraft varied substantially. In the one MTW (Operation Desert Storm) in which the United States and its NATO allies participated, the United States contributed roughly 25 percent of its fighter forces, and four major NATO allies made the following contributions: U.K., 28 percent; France 15 percent; Italy 5 percent; and Canada 23 percent.[22] Therefore, for this analysis, we postulate that each country might reasonably supply a similar percentage of fighters to a future conflict of similar scale.

In the case of the U.S. Air Force, we primarily used a slightly modified form of the force deployment described in Ochmanek et al. (1998), which is consistent with historical data. This force is constructed to first support the "enabling" portion of the halt phase (e.g., rear-area asset protection, SEAD and air superiority, and disruption of enemy C3 and transportation networks) and then to support attacks on enemy armor columns. In place, prior to the outbreak of open hostilities, are two squadrons of F-15Cs and a single squadron each of F-16CGs (with LANTIRN), F-16CJs (with HTS), and A-10s. The analysis also assumes that a Navy aircraft carrier is in theater as hostilities commence, resulting in the immediate availability of four F/A-18 squadrons (48 total combat-capable aircraft). When the "enabling" phase transitions to the armor column attack phase, force deployment emphasis shifts to precision-strike-capable aircraft (e.g., F-15E, F-16CG).

This analysis relies on a slightly modified and augmented bomber force compared to that described in Ochmanek et al. (1998), the primary difference being the addition of 18 B-52s and the reduction of B-1s from 50 to 28. Some bombers flying in from CONUS begin arriving relatively early on to support "enabling" operations. The bulk of the bombers arrive in time to support the armor column attacks.

---

[22]See Office of the Secretary of the Air Force (1993).

Finally, we postulate that a minimum airborne component of C3ISR assets (AWACS, JSTARS, Rivet Joint, UAVs) has been flown into theater and are available to provide tactical warning, situational awareness, C2, and targeting support for bomber and fighter forces when combat operations begin.

The allied air forces are assumed to deploy a total of 222 fighters. We postulate that these aircraft were contributed by the U.K., France, Italy, and Germany. All of these nations, except Germany, contributed aircraft in Operations Desert Shield and Desert Storm, and each has compelling economic interests in the region. Each nation deploys between 15 and 20 percent of its fighter force structure to the region, numbers that are in line with historic experience. In future coalition operations, the actual contribution may vary widely.

We did not include fighter forces from the other NATO nations principally because they are unlikely to bring any significant precision interdiction capability against armored vehicles and are unlikely to make significant investments in such weapons by 2010 (see Table 10.2).[23] Although forces from these other nations could support DCA and strike operations, we chose not to include them in the initial phases of the campaign because of the nature of the scenario and the posture of those air forces.

We envision a short-warning scenario that quickly leads to open hostilities and necessitates the rapid deployment of additional fighter forces to the theater. Under these postulated conditions, many of the steps needed to coordinate combat operations of different air forces (establishing command and logistical support relationships, integrating the aircraft into the ATO, etc.) would have to be compressed into a very short time frame.

Given the extraordinary demands on the Joint Force Air Component Command (JFACC), potential theater aircraft beddown constraints, and the limited capabilities offered by the fighters of some of these nations, we assume that the ComCJTF, based on recommendation of the JFACC, limits the number of air forces that participate early on

---

[23]The table indicates that the Netherlands is acquiring advanced air-to-ground precision munitions and may choose to participate in future coalitions. However, its contributions were not considered in this analysis.

rather than accepting all possible contributions. In addition to their interdiction capabilities, the nations we selected to participate in the initial phases of the halt campaign appear to be developing the capability to deploy forces more rapidly than in the past to a greater degree than the remaining countries.

We also postulate that fighter aircraft contributed by the non-NATO allies in the region of conflict are not available for the antiarmor mission in the first couple of weeks of the campaign because they are tied up in DCA. Thus, they are not included in the interdiction analysis.

Notional Deployment. Based on the power projection capabilities that the United States has developed, it is normal practice for the United States to prepare for deployments with respect to specific events and decision points. Typically, indications and warning (I&W) trigger the decision process to deploy forces to theater, with the specific deployment based on a time-phased force deployment document (TPFDD); the actual deployment decision day is normally designated as C day. This decision follows substantial deliberations, often time-consuming, among the senior leadership in the U.S. government, often in consultation with its allies, and is made by the national command authority.

U.S. allies undertake similar deliberations and may reach a decision before or after the United States They may decide not to deploy forces early in the conflict or not to deploy forces at all. Decision-making within the NATO Alliance framework is likely to be more complex and subsequently require more time. Another important event in the deployment process is the actual start of hostilities, which is normally designated as D day.

From crisis to crisis, C and D days will vary. By definition, in a short-warning crisis, D day occurs quickly after I&W, and C day hopefully occurs before D day. For this analysis, we envision a relatively short-warning scenario (on the order of several days) that allows for the deployment of U.S. C3ISR assets and a slice of essential support (e.g., tankers, ground control elements, weapons of choice) before hostilities begin. However, the decision to deploy additional U.S. fighter forces to the theater does not occur until D day. Decision times for coalition partners to deploy will vary as well from crisis to crisis.

Because of this wide variability in coalition decision times and to illuminate the importance of strategic interoperability, we postulate U.S. fighter deployments under two distinct conditions. The first condition is when there is support from the NATO allies (ranging from access to bases and overflight to deployments of fighter aircraft). The second is when this support is denied (or the United States is unwilling to wait because the decision will not be timely even if favorable), thereby requiring the deployment of CONUS fighter forces with en route tanker support staged from the United States and at the other end in Saudi Arabia.[24] The latter condition specifically illustrates the importance of strategic interoperability.

With NATO allies' support, the United States can potentially have some CONUS-based fighter squadrons in theater conducting air superiority and interdiction operations within three days of being directed to deploy (in the postulated scenario, that is within three days after hostilities begin). We further estimate that completing the deployment of the fighter forces postulated in this analysis would require about eight days (Appendix D provides more details of our deployment analysis).

This quick-response, out-of-area deployment estimate assumes that the fighters are routed from CONUS bases via great-circle routes over Canada and England into notional German air bases for an en route stopover, then across eastern France into the Mediterranean, and their over Egypt, the Red Sea, and Saudi Arabia to the Doha, Qatar, area in the Middle East—routes that avoid passing over Switzerland, Austria, Eastern Europe, and sensitive Middle Eastern nations. The analysis postulates aerial refueling of fighters by U.S. tankers, staged as needed at NATO allies' air bases.

The analysis also takes into account the refueling of airlifters bringing a notional slice of cargo, with the remaining fighter support either prepositioned or delivered by lift forces prior to the start of combat.

For the second condition, in which allied support (basing, overflight, etc.) is not available, U.S. deployment rates are necessarily delayed.

---

[24]We chose the nonsupported case to determine if it is plausible, what resources are essential to undertake such deployment, and a first-order time line for accomplishing the missions.

While one squadron from CONUS may be available in theater within three days, we estimate that the lack of access to allied support will necessarily delay the completion of the notional U.S. deployment to nearly 14 days. In this case, the fighters fly a great-circle route over the Atlantic through the Strait of Gibraltar, over the Mediterranean, and over Egypt, the Red Sea, and Saudi Arabia to air bases in the Doha area.[25]

Among important factors that can delay the overall deployments are increased operational risk (much longer flight times because of no en route stop), lesser availability of divert air fields, and increased difficulty in coordinating refuelings when tankers from CONUS accompanying the fighters have to be refueled sufficiently to allow for refueling of fighters. For certain fighters, tankers staged in SWA may also be needed. Also, potential diplomatic clearance problems and beddown issues (number of air facilities and associated infrastructure support that the host country is willing to provide at destinations) may arise during deployments. To capture these factors, we assume that only one squadron of fighters can arrive at the destination per day.

U.S. long-range bombers are a unique asset within the NATO alliance—our NATO allies do not have similar capabilities—and provide a significant interdiction capability.[26] The bombers are assumed to initially deploy from CONUS and then return to in-theater locations (e.g., Diego Garcia) after each sortie.

U.S. Naval and Marine Corps F/A-18s deploy from carriers, with the first carrier assumed to be in the theater at the start of combat. An additional carrier arrives seven days later. We assume that one-half of the F/A-18 force is available during the first critical seven days to participate in the halt campaign against the advancing enemy armor columns.

---

[25]Although not considered here, the use of Moroccan airfields as en route stopovers for fighters and airlifters and as tanker operating bases could be an alternative to NATO bases used in the supported case. However, bilateral agreements between the United States and Morocco are required far in advance of hostilities to develop the necessary infrastructure.

[26]Bombers, with their inherent long-range capabilities and large weapon payloads, typically account for a large fraction of the enemy kills in the early phase of a halt operation.

We also considered the contribution of NATO allies' fighter forces in this notional, out-of-area conflict. We assume that their deployment rates are similar to those of the United States, with any shortcomings in their power projection capabilities being offset by their closer proximity to the theater and the availability of air bases en route for refueling and cargo staging. Although deploying at the same rate as U.S. forces would be difficult for the NATO allies today, we assume that they develop the necessary force posture to rapidly deploy selected units in support of this category of operations.[27]

Force Allocation for Antiarmor. Our allocation of air assets for this analysis is summarized in Table 11.1, specifically highlighting the contribution of air forces to the antiarmor portion of a notional halt campaign requiring quick response from the United States and its coalition partners. When the antiarmor allocation is combined with the two deployment schedules (i.e., nonsupported and supported cases), we can depict the number of aircraft that are available for the antiarmor mission as a function of time (see Figure 11.4). The value of NATO support is evident. Not only are the CONUS-based fighters deployed to theater faster because of access to allied bases and overflight rights, but the number of aircraft available early in the conflict is even larger when additional support in the form of allied fighters is provided. U.S. bombers used in the antiarmor mission are depicted separately; they are not affected by the level of NATO support. The differences between the two sides of the figure will be major drivers in the results of our analysis.

---

[27]The NATO allies' capabilities for timely engagement in out-of-area operations are limited (see the International Institute for Strategic Studies' *Strategic Balance*). They are generally well endowed with tactical combat (and to a lesser extent with tactical reconnaissance) aircraft. Nevertheless, they lack long-range bombers, and their airlift capabilities are limited in their actual capacity. Coupled with the limited investment in aerial refueling, most NATO allies have limited capability to deploy combat forces to non-European theaters.

Some of the larger NATO nations have noted these shortfalls in recent internal defense reviews and, collectively, the NATO nations (in their Defence Capabilities Initiative) have recognized the need to enhance their ability to rapidly deploy their forces over the next several years. These steps include procuring additional airlifters and fast sealift ships and making changes to the configuration and posture of current units to make them more rapidly deployable.

Table 11.1

Force Allocation

Country	Platform	Forces Deployed	Antiarmor Mission	Other Missions[a]
United States	F-15E	66	66	—
	F-16CG	102	102	—
	B-1, B-52	46	38	8
	F/A-18C/D	48	—	48
	F/A-18E/F	48	48	—
	F-16CJ	36	—	36
	B-2, F-117	26	—	26
	F-15C, F-22	108	—	108
Allies	Tornado IDS	61	31	30
	Mirage D/N, 5	16	8	8
	Rafale	48	24	24
	EF-2000	48	24	24
	Tornado ECR	49	—	49

[a]For example, reactive and lethal SEAD, other strike, and air-to-air missions.

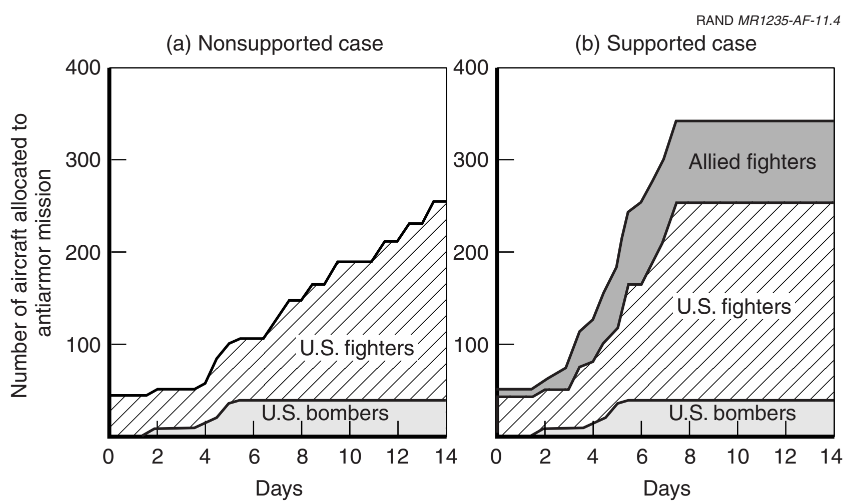


Figure 11.4—Number of Aircraft Allocated to Antiarmor Mission as a Function of Time

Sortie rates and weapon carriage are also important inputs, and those used in this analysis are consistent with estimates taken from joint-service studies, other DoD analyses that examined campaign-level effectiveness, and Ochmanek et al. (1998).

As discussed in the preceding section on engagement-level considerations, we postulate that the weapons of choice for the U.S. forces for the halt operation are JSOW and WCMD. JSOW/BLU-108s (the appropriate variant for antiarmor employment) are expected to number 2500 for the Air Force and 900 for the Navy in the 2010 time frame.[28] Additionally, the Air Force is expected to have another 5000 WCMD/BLU-108s, also appropriate against armor targets. Both services should have large quantities of the CEB variant of JSOW, while the Air Force should have large quantities of the CEB variant of WCMD, to attack the nonarmor elements interspersed along the advancing armor columns.

Because the target set contains 50 percent armor targets and 50 percent nonarmor targets, we allocated roughly equal quantities of BLU-108 and CEB variants during each day of the halt campaign. JSOW and WCMD effectiveness were based on the values shown in Figure 11.3. We used the "on-road" values because the armor columns were assumed to be on a road march and the operators on JSTARS were assumed to have accurate road maps. Also implicit in these effectiveness values is the assumption that JSTARS and other ISR assets provide good target discrimination and bomb damage assessment (BDA) to the fighters and bombers.

We assume that the F/A-18s switch to other missions after the Navy inventory of JSOW/BLU-108s is depleted. Similarly, when the Air Force depletes its inventories of JSOW/BLU-108s and WCMD/BLU-108s, we assume that the fighters transition to direct attack PGWs (e.g., Mavericks) and the bombers switch to other missions.

A few U.S. major European allies will have some standoff precision-weapon capability by the year 2010, but most of these weapons will have unitary warheads and thus are unlikely to be used against

[28]Because U.S. military strategy stipulates the ability to conduct two nearly simultaneous MTWs, the United States may choose not to employ all these weapons in a single MTW, as assumed in our analysis.

moving vehicles. Thus, the coalition partners are limited to employing direct-attack PGWs (e.g., Mavericks) against moving vehicles. We assume that they will have less than 1000 during this time frame. The allied fighters conduct other missions once these stocks are depleted. Because these capabilities are limited relative to U.S. capabilities, we considered an excursion in which the NATO allies acquire advanced weapons with antiarmor submunitions such as JSOW and WCMD or their equivalent. In this case, we assume that allied inventories are proportional (relative to force structure size) to those of the United States

Attrition and Weapon Employment Strategy. Losses for conventional aircraft against the expected short- and medium-range air defense threats are notionally categorized by weapon delivery profile. The loss rates we used were based on recent operational experience and are consistent with those used in prior RAND studies. For this analysis, we assume that initial (day 1) aircraft losses per sortie would be 0, 0.2, and 2 percent *if* standoff weapon delivery (JSOW), high-altitude direct attack (e.g., WCMD), and low-altitude direct attack (e.g., Maverick) are used, respectively. These loss rates would decrease over time as the air defense capabilities are degraded (e.g., lethal SEAD operations, reactive SEAD such as HARM engagements, and destruction of air defenses interspersed within the column of targeted armored vehicles).

Because aircraft attrition is an overriding concern for all air forces, we assume that the U.S. weapon employment strategy gives preference to standoff weapons such as JSOW over high-altitude direct-attack weapons like WCMD. The strategy is assumed to prefer both of those weapon types over low-altitude direct-attack weapons like Maverick. Using this strategy, U.S. JSOW inventories are sufficient for approximately seven days of the halt campaign (ten days for the no-access case). Thus, no U.S. losses are expected during this first week of JSOW employment. At this point, the Navy fighters switch to other missions and the Air Force fighters and bombers begin using WCMD. Although U.S. losses begin to accumulate during the second week of operations, they remain very low (less than one aircraft after 14 days) because of the success of SEAD operations and the strikes against the armor columns, which include targeting air defenses interspersed along the columns.

The NATO allies, on the other hand, have low-altitude direct attack weapons (e.g., Maverick) and would likely incur significant aircraft losses on a daily basis, perhaps as high as an aircraft per day on average, if they were to use such weapons early in the halt campaign (option one). Although this may be judged acceptable under some circumstances, it is likely that a great many conflicts will not warrant such risks to allied air forces. One alternative (option two) is to delay allied participation in the antiarmor mission until later in the campaign, when the threat from air defenses has been greatly reduced; in this case, their assets would initially be redirected to other operations such as air superiority. Another option (option three) is to assume that the allies have acquired sufficient inventories of JSOW and WCMD or their equivalents so that they may participate early and effectively in the antiarmor mission with risks comparable to those of the U.S. air forces. We considered all three options of allied contributions to the halt campaign but focused on the third option.

Results. The value of the interoperability of U.S. and NATO allies' air forces, in the context of our notional multiday air operation against advancing columns of enemy armor, is illustrated in Figure 11.5.[29] We use the term "notional" to indicate that, while there was an attempt to illustrate the results of interdiction missions in the context of an air campaign, the results are not definitive in an absolute sense but are representative in a relative sense and can thus be used to illustrate the military impact of a diverse set of interoperability issues.

Figure 11.5 compares cumulative numbers of enemy AFVs stopped as a function of days for three cases in an out-of-area, quick-response scenario spanning different levels of U.S. and allied participation. As stated earlier, we use as our notional measure of effectiveness the number of days required to stop 50 percent (i.e., 1500) of the enemy's AFVs. In our model, the amount of time needed to achieve this objective is a function of the rates at which JSOW or WCMD carrying BLU-108 submunitions are being delivered. The

---

[29]The results shown in the figure were calculated using a desktop computer model that RAND developed to analyze the halt phase of a campaign. The model was programmed in Analytica™, a visual-modeling system that runs on either a PC or a Macintosh computer. Analytica™ was originally a product of Carnegie-Mellon University and is now distributed, maintained, and extended by Lumina Decision Systems, Inc.

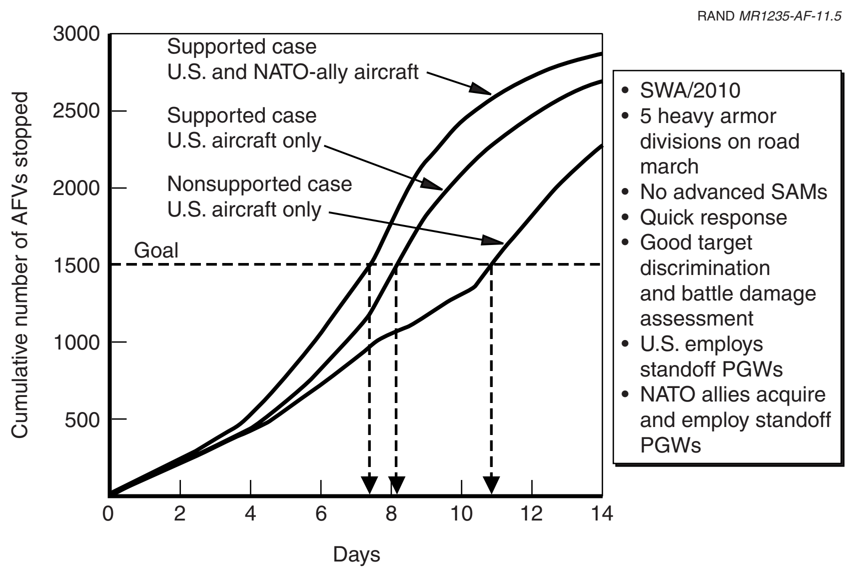


Figure 11.5—Access to Allied Bases and Airspace May Be More Important than Allied Aircraft/Weapon Contributions

weapon delivery rates are, in turn, dependent on the sorties rates and weapon carriage for each aircraft type and on the number of aircraft available to conduct the antiarmor mission (from Figure 11.4).

Note that the assessment does not account for enemy armored vehicles that might be damaged or destroyed by regional ground forces or any U.S. predeployed ground forces. It is assumed that the number of such kills will be modest in this type of short-warning scenario. Hence, these results are somewhat conservative.

Also note that these results illustrate halt potential against an enemy defended by the air defense threats described earlier, except that there are no SA-12s. Although we did not explicitly analyze such a scenario, the impact of the SA-12s' presence is discussed later in notional terms.

We first considered a case in which the NATO allies did not contribute forces or allow access to NATO allies' infrastructure or airspace. In this case, the halt campaign is conducted solely by U.S. fighters and bombers. The results illustrate the importance of NATO allies providing access to bases and airspace during the critical first few days of deployment. Without access, it may take nearly 11 days to halt the enemy's advance. With access to NATO allies' infrastructure (the second case), U.S. forces can be deployed more rapidly. As a consequence, the time required to accomplish the halt is reduced by three days. Each such day is critical not only because of the need to limit enemy incursion into friendly territory but also because air assets are in limited supply in the early stages of a conflict and are often needed to respond to other pressing and competing areas of operation simultaneously.

As noted earlier, half the interdiction sorties carried BLU-108 variants of JSOW and WCMD and half carried CEB variants. As an excursion (not shown in Figure 11.5), we also considered an alternative munitions allocation in which 100 percent of the force employs the BLU-108 variants of JSOW and WCMD, switching to the CEB variants only after the stock of BLU-108 variants has been depleted. In this excursion, the halt time decreased by approximately two days with NATO support and three days without NATO support. Even with this new munition allocation, access to NATO allies' infrastructure reduces the time to halt the armor columns by about two days.

The remaining curve in Figure 11.5 (case three) explores the potential impact of additional allied support. In this case we assumed that the NATO allies have acquired advanced weapons with antiarmor submunitions such as JSOW and WCMD or their equivalent (this is the third of three options for allied fighter participation in the halt operation that we examined). We also assumed that allied inventories of JSOW and WCMD are proportional (relative to force structure size) to those of the United States. Because the weapons can be delivered at ranges beyond most of the terminal defenses, their aircraft attrition is low (and comparable to U.S. aircraft attrition while delivering JSOW and WCMD). Allied contributions under this set of circumstances are estimated to shorten the halt operation by a full day. If the NATO allies improve their readiness posture and are able to deploy more forces to theater during the critical halt phase, their contributions would have a larger effect. Results for the other two options for allied fighter participation are not shown because they were less effective than the third option.

The presence of the SA-12 would invariably alter U.S. and allied force allocation strategies and tactics, placing more emphasis early in the campaign on SEAD and in particular on the destruction of the important components of this system (e.g., the radar tracking elements). Until the SA-12 threat is eliminated (which may take several days), armored vehicle attacks by conventional aircraft (U.S. and allied) may be limited owing to their extreme vulnerability to the threat. Since the bulk of these aircraft do not arrive in theater for several days, short delays in SA-12 suppression may not have a significant impact on the time required to halt the armored vehicle column. Longer delays, however, could be more troublesome. In that case, one potential force allocation would be to employ the B-1s and some of the B-2s, delivering JSOW, in order to initiate attacks against the armor columns. Of course, any reallocation of B-2s would probably impact other critical mission areas, namely strategic attack and SEAD.

In summary, the acquisition of advanced weapons would clearly improve overall allied effectiveness in an air campaign against advancing armor columns. However, a substantial allied investment would be required. The level of investment needed is in excess of what NATO allies have historically spent on air-delivered munitions. A more critical benefit that the allies can provide to the United States in conducting such an operation is immediate access to NATO allies' infrastructure and airspace (e.g., tanker basing, overflight rights).

The preceding discussion focused on the halting of enemy armor columns, which is just one aspect of the air campaign. Rather than employ allied air forces to attack moving armor, they could be allocated to target sets better suited to their current air-to-ground capabilities. In particular, we considered allocating their assets to another important mission, the destruction of critical infrastructure and other (mostly) fixed targets that contribute to the enemy's ability to prosecute the invasion. These targets are large in number and diverse in characteristics. The list includes petroleum refineries and pumping stations, aircraft production facilities, power plants, bridges, railroad yards and their associated facilities. It also includes important communications and C2 nodes.

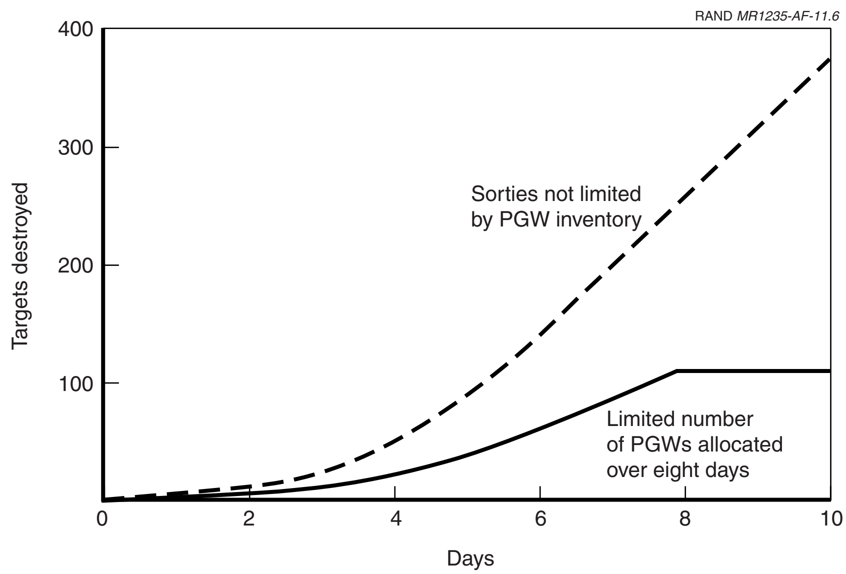


Figure 11.6—Critical Infrastructure Targets Destroyed by Allies

Figure 11.6 shows the potential numbers of these targets destroyed by allied air forces using PGWs with unitary warheads, assuming the NATO allies' air forces that were once allocated to attacking moving armor are now reallocated to critical infrastructure targets. If these targets are defended by highly capable air defenses, substantial SEAD assets would be required to conduct such missions. If the sorties are not limited by PGW inventories (assuming that the allies purchase additional laser-guided bombs or GPS-guided munitions like JDAM), they have the potential to destroy about 350 of these targets over a ten-day period.[30] In cases where their inventories are limited, the estimated number of targets destroyed will be less. In this latter example, we assume a total inventory of 1000 allied PGWs delivered over an eight-day period, matching the approximate length of the concurrent halt campaign.

[30]The number of weapons needed to destroy the wide range of targets varies greatly depending on the number of aim points and the weapon effectiveness.

OBSERVATIONS

U.S. and its NATO allies' air forces are and likely will continue to be adequately interoperable in air-to-air operations, particularly in air surveillance, air combat patrol, no-fly-zone enforcement, and DCA missions against aircraft and moderately stealthy cruise missiles. Interoperability should improve over time with the integration of MIDS and upgrades to the AWACS fleets. However, the United States is well ahead of its allies in developing ballistic missile defense capabilities and therefore currently bears a major burden in force protection of coalition forces. To minimize the risk of allied forces to ballistic missiles attacks, the allies should leverage U.S. investments in this area and pursue complementary efforts such as interoperable communications and data exchange systems, interoperable radars, and weapon systems.

The increasing gap between the United States and its allies in all-weather, standoff PGWs and smart submunitions for attacks on moving targets poses a greater interoperability challenge in future coalition operations. If U.S. allies do not commit to proportionately comparable investments in such capabilities, the role of their air forces in future air-to-ground operations, which increasingly demand attainment of military objectives with minimal casualties and collateral damage, will likely decrease substantially.

Currently, the NATO allies' air forces are not configured to rapidly deploy a substantial number of fighters to out-of-NATO-area operations.[31] Improvements in force posture, airlift, and aerial refueling capabilities need to be made to support a strategy that includes quick intervention in conflicts.

The United States greatly benefits from allies' support for deployment operations such as the one envisioned in this campaign.

---

[31] In Operation Allied Force, NATO employed large numbers of fighter aircraft in a contingency that was technically out of area. However, many of the aircraft were able to operate from their home bases because of the bases' proximities to the area of operations. Of the aircraft that did deploy, all were able to use existing NATO air bases. In addition, NATO had been operating in the area for several years and was given ample warning. These circumstances may not be repeated in future out-of-area operations that are some distance from NATO territory, such as possible future air operations in SWA.

Access to allies' airspace, air bases, and infrastructure is crucial to such deployments. These strategic interoperability benefits are vital to future U.S. interests and should not be jeopardized by operational and tactical interoperability issues.