Summary

Background

Ever since WWII, the importance of close support—defined as responsive, flexible fire support that is needed near enough to friendly forces that it requires detailed integration and coordination—has been well understood by ground commanders. Typically, fixed-wing aircraft, artillery, and, since Viet Nam, helicopters provide that support. Much of the analysis of close support needs has been done with a Cold War scenario in mind, where the threat, weather, and terrain were relatively constant. Only the variables of mobilization and warning time, strategic deployment, and the use of nuclear weapons were explored routinely.

But as Desert Storm and other operations since the end of the Cold War have made clear, the demands on U.S. forces have changed, and defense needs have changed along with them. The focus has shifted from the North German plain and the Fulda Gap to Haiti, Rwanda, Somalia, and Bosnia. Thus, defense planners no longer have a single scenario against which to plan, and they might reasonably ask if the need for close support has changed along with the much richer variety of scenarios U.S. forces must now contemplate. Indeed, some have even argued that the need for close support has all but disappeared in light of the U.S. ability to shape the close battle through interdiction.

An analysis of the operations conducted since the end of the Cold War suggests other common characteristics in addition to a change of venue. Most obviously, U.S. forces must adopt a contingency focus. Furthermore, they can anticipate working with a range of allies. Although recent operations have shown a willingness on the part of the U.S. to commit its forces to a wide range of operations in many locations, they also reveal an expectation that the U.S. will neither sustain many casualties in carrying out these operations nor cause many among the civilians who may be caught up in conflicts. Finally, these recent operations reflect a change in national interests and thus goals, making peacekeeping and peacemaking primary objectives.

Purpose and Approach of This Study

This study attempts to determine whether the ground commander’s needs for close support have changed and, if so, the unique characteristics of the systems that can meet these different needs. To do so, the study team identified four categories of battlefield situations in which close support could be critical. These four situations address most of
the types of operations the U.S. is likely to carry out in the new national security environment. Not explored were operations similar to those of the Cold War, since abundant analysis exists on these sorts of engagements. The four categories examined here are as follows:

- Augmenting allies or other partners
- Supporting light infantry
- Handling “leading edge” problems (i.e., the problems faced by the first U.S. troops deployed in a major conflict when the enemy has the initiative and probably a substantial numerical advantage)
- Supporting offensive operations (these differ from the typical Cold War scenario in that the United States has seized the initiative and is on the attack)

To explore the issues associated with these four situations, researchers developed a series of detailed combat vignettes. These vignettes were run on a high-resolution combat simulation. The focus was on determining how much additional support would be needed in the form of fixed-wing aircraft, helicopters, or advanced artillery to ensure a successful outcome. The seven vignettes developed and the combat situations they represent appear in Figure S.1.

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**Augmenting Allies**
- Escort of a Humanitarian Convoy
- Support for an Allied Enclave

**Supporting Light Infantry**
- Small Unit Infantry Assault
- Small Unit Infantry Patrol

**“Leading Edge” Problems**
- Hasty Defense by Light Forces
- Prepared Defense by Light Forces

**Supporting Mechanized Offensive Operations**
- Armored Force Meeting Engagement

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**Figure S.1—Critical Combat Situations and Supporting Vignettes**

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1 The simulation consists of a networked system of databases, analytic tools, and models, including JANUS (a ground combat model), CAGIS (a cartographic system), and BLUE MAX and CHAMP (flight path simulations for fixed- and rotary-wing aircraft).
Study Results for Critical Combat Situations

Each vignette had different criteria for success. Each assessment took into account the point at which the unit would no longer be able to continue its mission. For example, in escorting a humanitarian convoy, success was equated with minimizing friendly casualties. In other cases, it was equal to accomplishing a specific mission. Each vignette started with a base case in which no close support was used. Following the base case run, each vignette explored different levels of effectiveness for the ground force to determine if a more capable ground force might obviate the need for close support. The analysis then determined if close support could affect the outcome, and, if so, what means of close support produced the best results. Below is a summary of the study results for each of the seven vignettes, all of which typify critical combat situations in the new defense environment.

Escort of a Humanitarian Convoy

This vignette envisions a 40-vehicle convoy being ambushed by 24 attackers armed with a range of light infantry weapons. In the base case scenario (i.e., no close support), about half of the convoy vehicles are destroyed, and the attackers suffer only two casualties. Changing the scenario by replacing the high-mobility multipurpose wheeled vehicles (HMMWVs) with Bradley fighting vehicles does not change things much, except that more attackers get killed. Because the casualties occur so quickly in an ambush, even the most responsive close support does not preclude substantial losses to the convoy.

Two key observations emerge from the analysis. First, do not get ambushed. Once an ambush is sprung, substantial convoy losses are virtually inevitable. No close support asset is responsive or lethal enough to preclude significant losses. This finding suggests that better intelligence assets are needed to locate ambushes before they occur, e.g., a radar that could locate small arms. Second, retribution may act as a deterrent. Retribution can not be indiscriminate; therefore, some way of marking or tagging individuals involved in an ambush might be desirable.

Support for an Allied Enclave

This vignette depicts an allied enclave on the edge of a city defended by a small friendly force equipped with tube-launched, optically tracked, wire command linked (TOW) missile launchers mounted on HMMWVs. Allies contribute a light infantry company to the defense. The enclave is attacked by three battalions of heavy and medium armored vehicles supported by light and medium cannon artillery. Researchers determined that losing no more than 25 percent of the defending force would constitute success. In the
base case, only about half of the defenders survive, and they kill about half of the attacking force.

Providing effective close support changes the situation, limiting friendly losses and eventually destroying most of the attacking force. Key observations that emerge from this analysis include the following. First, using advanced artillery in this situation faces a number of challenges. Urban environments limit the number of locations in which to place artillery systems, and these would be easy for an adversary to identify in advance. The artillery itself is a lucrative target for counterbattery fire. Second, good battlefield information can improve the performance of both the organic and close support systems markedly. Good information enables the ground commander to position his systems to the best effect. It also enhances the synergy between the organic and close support systems. Third, to succeed, close support aircraft, fixed-wing or helicopter, have to kill enemy vehicles at a high rate. Given the confined airspace around the enclave, the close support assets have to kill multiple enemy vehicles on each pass. Finally, a better match between the shape of the target and the effects pattern of the munitions would improve the results of fixed-wing aircraft. The sensor-fuzed weapons (SFWs) used in the simulation have a long but narrow effects pattern, which has the most effect when the target has the same geometry. When the target has a different pattern, the effectiveness of the munitions falls off rapidly. However, munitions with terminally guided submunitions that are not as sensitive to target geometry kill substantially more armored vehicles. While these munitions cost more, their increased effectiveness seems to warrant the added cost.

**Small Unit Infantry Assault**

In this vignette, a platoon-sized Special Operations assault force has the task of neutralizing a high-priority apparatus located inside a military complex surrounded by guard towers. To be successful, the assault team has to get inside the complex, breach the storage facility, and destroy the apparatus without losing more than 25 percent of the force. The facility is defended by a 32-person security element, a 36-person immediate reaction force (IRF), and a company-sized quick reaction force (QRF) located nearby.

The base case results are a disaster: None of the assault team survives long enough to penetrate the storage facility. The fire delivered from the guard towers is devastating. When close support is brought to bear on the towers, the survivability of the assault team soars, and when it is applied to both the towers and the IRF, the results come very close to satisfying the criterion for success.

The main analytic lesson from this vignette is that the operation can not succeed without close support but that the type of support matters. One close support system analyzed was a conceptual NLOS/EFOG-M (non-line of sight/enhanced fiber-optic-guided
missile). It could not destroy the towers fast enough, so a mix of close support systems was needed. Combinations of F-117s with laser guided bombs (LGBs), EFOG-M, helicopters with Hellfire missiles, and 60-mm mortars all produced about the same results. However, destruction of IRF barracks always required a fixed-wing aircraft.

**Small Unit Infantry Patrol**

This vignette features a platoon-sized infantry patrol in a city in the Balkans. Returning from a routine patrol, the unit is ambushed by 51 irregular infantry occupying multi-story buildings along the patrol’s return route. The kill zone for the ambush is a street flanked by 10-story buildings. Success is determined by the number of friendly infantry that survive the ambush.

In the base case, no one survives. About 12 members of the ambush are killed, but enemy casualties are not the measure of success. If some of the buildings could be neutralized (along with the enemy infantry in them), the patrol’s chances of surviving would improve. However, no close support systems can deliver the needed capability in time to affect the outcome. As with the ambush described above, events move very fast, and springing the ambush is tantamount to enemy success. Again, the goal would be to avoid the ambush altogether. A second lesson is that responsiveness of a close support system is crucial. The engagement lasts two minutes. Support that arrives after that may exact casualties on the enemy force, but it will not affect the outcome for the friendly force. The analysis suggests that only helicopters flying over the patrol can be responsive enough to react in time. However, even though helicopters can be responsive enough, that does not mean that they can be effective enough to influence the outcome. The target location problem (infantry hiding in buildings) is severe. As with the earlier ambush, discriminative retribution may deter ambushes, but identifying and tracking those of the enemy that participate in ambushes is difficult.

**Hasty Defense by Light Forces**

The strategic mobility of airborne, air mobile, or marine forces makes them the ones most likely to be committed as the initial, or “leading edge,” part of a response to an aggressor. The vignette modeled in the simulation pits elements of an airborne brigade against a two-regiment attacking force. The friendly force is largely light infantry, but it has about 40 vehicle-mounted anti-tank weapons, 10 light armored vehicles, and 6 Apache helicopters. The enemy has about 275 armored vehicles and supporting artillery.

Success for the friendly force hinges on its ability to destroy enemy vehicles at a distance while retaining 60 percent of its forces. To survive, the friendly force needs to destroy about 25 percent of the attackers. In the base case, the friendly force loses almost all of its
fighting vehicles and its helicopters. The enemy sustains heavy casualties but succeeds in capturing its objective, a critical road junction. Close support helps, but not enough. Even with close support, the friendly force still suffers too many casualties and does not kill enough enemy to meet its criterion for success.

Several points emerge from the analysis of this vignette. Close support by itself may not be adequate to offset the large disparity between the attacker and the defender. To hold out against armored forces, light forces need support that can deliver a high rate of fire and kill clusters of vehicles. They also require long-range and survivable target acquisition systems that enable them to engage the enemy before being engaged themselves. Responsive fires are necessary to compensate for a lack of tactical mobility.

Alternatives to solving this problem need to be considered. Some of the analysis suggests that more capable ground forces in concert with close support might be able to handle this very demanding situation. Other alternatives should also be considered, e.g., interdicting the enemy before he is able to close with the friendly force and bring his overwhelming direct and indirect fire assets to bear.

**Prepared Defense by Light Forces**

This case features a light infantry brigade defending a critical road junction in Southwest Asia against an advancing enemy armor division. The brigade has three battalions of light infantry, 58 vehicle-mounted anti-tank systems, and 14 light armored vehicles. The enemy force has just over 500 armored vehicles.

Success for the friendly force is defined as retaining 60 percent of its force while inflicting 40 percent casualties on the enemy. That level of losses will preclude the enemy from continuing his mission to seize the road junction. The base case results are much more favorable for the friendly unit than in the hasty defense, underscoring the importance of prepared positions. Slightly less than half the friendly force survives, and only 45 percent of the attacker. The friendly force inflicts sufficient casualties on the enemy to meet the criterion for success but does not retain enough of its own forces. Effective close support both increases the number of enemy casualties and enhances the survivability of the friendly unit because fewer enemy are available to inflict damage.

Some of the analytic lessons mirror those of earlier vignettes. Matching munitions effects patterns with target arrays enhances munitions effectiveness. More capable munitions can help resolve some of the target location difficulties. One insight is that ongoing efforts to develop more effective artillery munitions, such as SADARM (sense and destroy armor) and BAT (brilliant anti-tank) do not appear to answer the close support needs as well as terminally guided sub-munitions concepts do. Adaptive targeting, e.g., provided by unmanned aerial vehicles (UAVs) in orbit over the battle, was also shown to
increase effectiveness. Further, it is clear that the close support systems have to match the strategic mobility of the light forces. The strategic mobility of the light units is the primary reason why they would be employed in this situation, and their close support systems must be able to accompany them. One insight here is that current artillery systems require more lift than helicopters do, and helicopters take more lift than fixed-wing aircraft do. However, when advanced smart munitions are added to the equation, all systems require significantly less lift (two to 10 times less), with the artillery benefiting the most.

**Armored Force Meeting Engagement**

This vignette has a reinforced brigade-sized unit encountering an enemy force of similar size. Both units engage from a march formation, with the enemy assuming a hasty defense, and friendly units launching a hasty attack. The success criterion for the friendly force is to destroy three-quarters of the enemy force while retaining 70 percent of its own force. The base case results show that about 30 percent of each force survives. Thus, the friendly force meets its criterion for neither lethality nor survivability. Actual close support systems improve both areas for the friendly force, but not enough to constitute success. In part, this results because the systems are limited to a close support role; that is, they are not permitted to interdict the enemy force. However, that limitation reflects real-world conditions when the enemy’s intentions are not known until the first shots are fired.

Analysis of the vignette results reveals the following points. First, the effectiveness of the SFWs modeled in the simulation was limited by the fact that the enemy forces dug in and limited the ability of the aircraft to match the effects pattern of the weapon (long and narrow) with the linear array of the target vehicles. Trading the SFWs for Maverick missiles only makes things worse in terms of aircraft attrition. In the main, the fixed-wing munitions could not be brought to bear before the enemy stopped and dug his vehicles in, thus largely negating the advantages of the munitions. On the other hand, the advanced artillery systems were effective. The targets were stationary, and the high angle of attack of EFOG-M and the Damocles launched by the multiple-launch rocket system (MLRS) took away the advantage of being dug in. Finally, the analysis indicates that serving the right target at the right time confers a premium. The use of UAVs to provide targets for the artillery enabled those systems to attack the most lucrative target sets.

**Overall Implications**

Looking across the analytic results for all the vignettes, we draw a number of conclusions. We discuss these first by describing the conclusions with respect to how
much close support is needed, against what kinds of targets, and with what degree of responsiveness. We then turn to the types of characteristics needed by close support systems to answer the needs. However, one of the lessons of this analysis is that not all needs relate directly to weapons systems. Munitions and information needs claim equal priority, so we offer some insights in these areas as well.

**How Much Close Support Is Needed?**

- **Ground forces need additional firepower in many situations.** In some cases, more effective ground units could provide the needed firepower. However, in other cases and in a broader range of cases, close support was necessary to achieve success. Typically, the results suggest that the close support assets kill enough enemy systems, but not always the right ones to ensure that enough friendly systems survive to achieve success.

- **In several plausible situations, the ground commander’s need for close support exceeds future capabilities.** In these cases, a successful outcome requires a combination of enhanced ground force capability and close support. Alternatively, it might be more practical to shape the battlefield by attacking road nets or interdicting enemy forces before they can close with friendly light units. However, in some cases—ambushes—no technical solution seems feasible. In these cases, detecting the ambushes and avoiding them offers the best solution.

- **The need to avoid ambushes is important in the new defense environment.** It has always been important to avoid ambushes. However, in the new defense environment, activities such as urban patrols and convoy escorts are increasingly likely and important. Ambushes are the most effective countertactic to these activities. So they, too, are more likely. Given the effectiveness they demonstrated in the simulations, avoiding them is the best option, since close support is neither responsive nor lethal enough to preclude friendly casualties.

**Which Targets Need to Be Attacked?**

- **Close support systems need to be able to deal with a mix of targets.** The range of vignettes shows that armored vehicles are not the only types of targets that U.S. forces will have to attack in the future. Some systems are better at attacking one type of target than another. Thus, a mix of systems will be required along with a range of missions.

- **Discriminative retribution may deter ambushes.** Avoiding ambushes is the preferred strategy. However, analysis suggests that it might be possible to find and kill the ambushing force after the ambush. This strategy is not recommended, since
indiscriminate retribution can have negative effects. But if those setting the ambushes had some reason to believe that they might not survive it, they might be deterred. Some research into target sensing and marking may prove beneficial.

• **Hitting the right target at the right time offers high payoff.** Although this is more of an information insight than a firepower one, it is nonetheless significant. Good targeting information, such as that provided by UAVs, enables friendly forces to attack the targets posing the greatest threat throughout the battle. This benefit is even greater than perfect information before the battle, which enables the force to attack high-value targets initially but not continuously.

**How Much Responsiveness Is Needed?**

• **Responsiveness is not simply a matter of time.** In one sense, response time is a false metric. It does not matter how fast the response occurs if it does not affect the outcome, as was the case with the ambushes. A more relevant measure might be kills per minute. Analysis across the vignettes indicates that the kill rate of current systems is inadequate to shift the results of a battle from the negative to the positive. Kill rate may have little to do with system responsiveness. Advanced artillery firing Damocles, which has a large footprint, was much more effective than artillery firing SADARM, which has a small footprint, but both arrive at the same time.

**Desirable System Characteristics**

One analytic finding of this research is that platforms—fixed-wing aircraft, helicopters—are not the only, or perhaps even the primary, focus. Munitions, sensors, and information are all important to how the battle ends. Thus, this section talks not only to platform characteristics but also to those of munitions, sensors, and information.

**Fixed-Wing Aircraft.** The strength of fixed-wing aircraft is that they can carry large weapons loads over long distances. However, the analysis in this study shows that they can not destroy armored vehicles fast enough except when carrying the most recent anti-armor cluster bombs. Thus, more sophisticated weapons would be useful, most particularly those that can acquire targets autonomously. Also desirable are the long-range target detection and recognition capabilities necessary for standoff delivery and “point-and-shoot” delivery. Development efforts also need to take account of the broader range of targets likely in the new defense environment.

**Rotary-Wing Aircraft.** These are survivable enough but lack the lethality necessary to tilt the balance of battles. Needed are faster target acquisition means and more rapid launch rates. Also important is a capability for helicopters to identify the air defense threat.
Finally, some low-observable additions would be useful, particularly when helicopters are used in support of operations by Special Operations Forces (SOFs).

**Advanced Artillery.** Artillery offers a number of advantages, particularly its ready availability in bad weather, darkness, etc. However, it is not very effective against armored targets, especially when they are moving. Thus, some investment in terminally guided sub-munitions (TGSMs) could raise the effectiveness of these systems. However, artillery systems would also benefit from work to enable them to attack a broader range of targets, e.g., point targets such as bunkers. To this end, systems based on fiber-optic guidance would be beneficial. Furthermore, some of the vignettes illustrate the need for a light mortar that soldiers can carry over rough terrain. Since the load they can carry is limited, munitions for this mortar need to be accurate and lethal enough to destroy point targets without requiring a large number of rounds.

**Sensor and Targeting Systems.** One of the more intriguing results of the analysis is that firepower questions can have an information-based answer. For example, the best strategy for avoiding an ambush is to avoid it. Thus, detecting and locating ambushes is the priority. If the threat can be located, the range of munitions and platforms available now can adequately deal with it. Another insight is that allocating fires can be as important as delivering them. The same number of kills could lead to victory or defeat, depending on how they were distributed. Information enables a better coordination of organic and close support assets. Adaptive targeting lets the ground commander attack the most lucrative targets as the battle situation changes.