Following Path 1: Enhancing the Current Light Forces

The previous chapter established a base case to see how well a light force such as the 82nd DRB equipped with modern capabilities—sensors, weapons, and support—would fare in repelling a capable larger heavy force. What we saw in all three scenarios was that the base case force did not fare well in a rapid-reaction role against a powerful, armored opponent. Given this outcome, what possible solutions might be available in the near future to enhance the current light forces and improve this outcome?

This chapter, which examines the consequences of following the first path described in Chapter One, looks at the results of upgrading current rapid-reaction forces with a near-term concept and enabling technologies. It does so by examining the RFPI ACTD (briefly discussed in Chapter One)—one of the most significant near-term looks at improving rapid-reaction capabilities.[1] The ACTD's goal was to "put maturing technologies in the hands of soldiers" to give them an opportunity to evaluate firsthand the utility of those technologies. The RFPI ACTD was specifically focused on evaluating new advanced concepts along with enabling technologies to help improve the light force's capability during the early phase of conflict.

We shall first describe the RFPI ACTD and RAND's role in it; we then examine some of the near-term RFPI ACTD concepts and enabling technologies. Finally, we examine the results of modeling these new capabilities in the same three scenarios used for the base case, again supplying a soldier's-eye experience of the SWA scenario and then following up with the after-action reviews of all three scenarios. As part of that review, we also examine how the upgraded DRB would do against a *future* heavy threat. Finally, we include an excursion that compares the enhanced fiber-optic guided missile (EFOG-M)—one of the key upgrades examined in chapter—with other indirect-fire system alternatives.

A key assumption in our analysis here of path 1 is that the basic DRB structure is held constant. Systems are added or deleted, but the basic organization of the DRB remains the same. As systems are added, others are deleted to hold the amount of required airlift relatively constant. In addition, no major enhancements are made to the tactical mobility of the DRB, again to remain within a fixed strategic lift allocation. Chapters Four and Five will examine other, more radical, alternatives to the current DRB when we assess the impact of following the other two paths.

What Is the RFPI ACTD?

The RFPI ACTD can be understood as a multifaceted experiment that employed the model-test-model paradigm, shown in Figure 3.1, in which near-term technologies

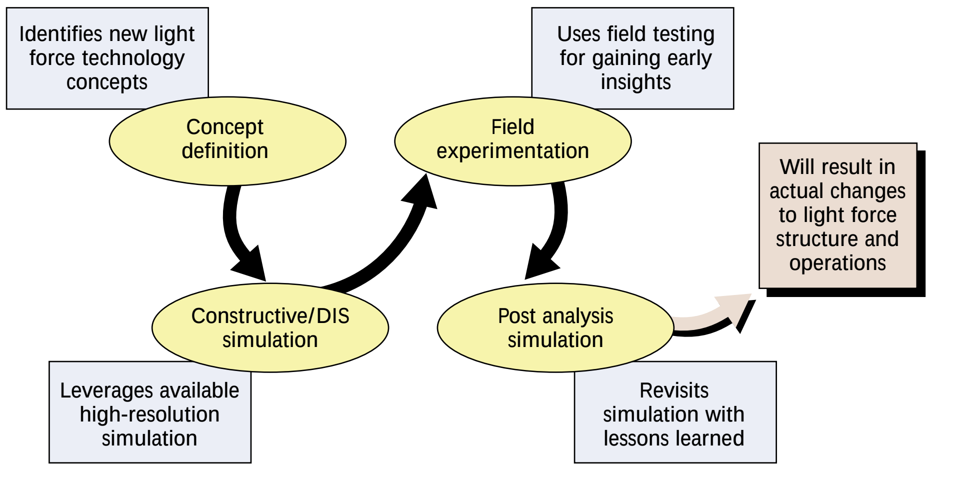


Figure 3.1—The Model-Test-Model Paradigm

applicable to light forces were identified, modeled, tested, refined, and, in some cases, actually introduced into the force. The effort began in 1992 and was managed by what was then known as the U.S. Army Missile Command (MICOM), located at Redstone Arsenal and overseen by what was then known as the Office of the Secretary of the Army for Research, Development, and Acquisition (SARDA). The first set of experiments were conducted and reported on in 1998.

The process starts with concept definition, in which new light force concepts are identified. Once promising concepts are identified, along with the technologies that enable them, some combination of constructive simulation and/or distributed interactive simulation (DIS) is used to examine how effective these concepts and technologies are in multiple scenarios (e.g., in different situations and varied terrain). (These simulation methods are described in more detail in Appendix B.) With relatively little investment, various concepts can be examined to see if they are worthy of pursuing in more expensive and time-consuming field or virtual experimentation. In this sense, the modeling activity is not by any means a stand-alone system designed to provide an answer for policymakers. Rather, it is a tool to "guide" policymakers and researchers and give them feedback on which avenues are the more promising ones to pursue. "Lessons learned" from the experimentation process are, in turn, analyzed in simulation, where more cases are run and then other variations explored. In principle, promising concepts that move successfully through the model-test-model paradigm would be implemented in the field, leading to actual changes to light force structure and operations.

RAND, as part of its Rapid Force Projection Technologies (RFPT) project, was a member of the simulation team led by MICOM. RAND's primary charter was to explore new technology concepts that could potentially improve U.S. light and airborne forces; as such, it had responsibilities in each stage of the model-test-model paradigm. For example, RAND was instrumental in the concept development of many of the new systems, in particular the hunter–standoff killer concept. RAND also participated in other parts of the ACTD, including observing field experiments of various advanced technology demonstrators (ATDs), interacting with various users for exploration of tactics, techniques, and procedures (TTPs), and performing much of the postanalysis constructive simulation. RAND's main contribution to the RFPI, however, was its responsibility for the JANUS-based constructive simulation and analysis environment discussed previously in Chapter One and in more detail in Appendix B.

RAND has a long history of exploring, analyzing, and modeling the types of systems envisioned for RFPI. In fact, RAND's early conceptual work on such light force options as "Bird Dog" and "Shotgun" (a hunter–standoff killer design)—which is shown in Figure 3.2—distributed sensor networks, low-observable scout systems, sensor-to-shooter C2 concepts, reduced crew platforms, and battlefield robotics helped in formulating the initial definition of the RFPI program. The results of these efforts are summarized in Steeb et al. (1995).

Other RAND projects at the time, such as Armor/Anti-Armor, Future Conventional Forces, Advanced Concepts for Light Forces, the Deep Fires Study, and Military Applications of Robotic Systems, were leveraged for contribution to RFPI.

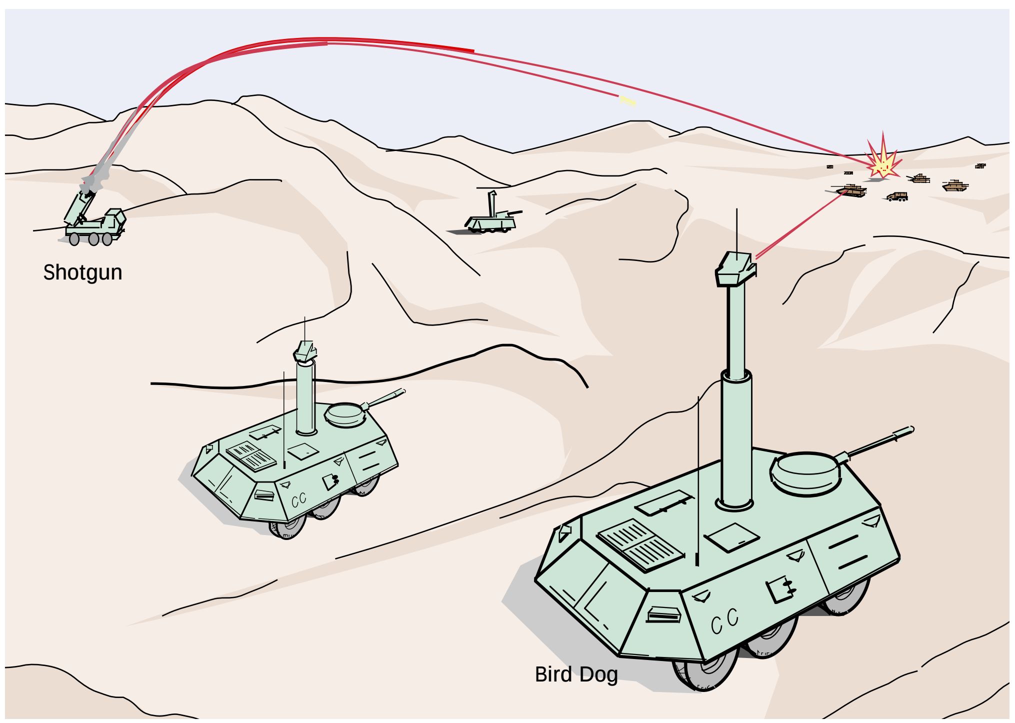


Figure 3.2—Depiction of an Early Hunter–Standoff Killer Concept

The Focus of RFPT: Exploring New Concepts Made Viable by Emerging Technologies

As mentioned above, RAND's efforts for the RFPI were under the auspices of the RFPT project, whose key goal was to explore new concepts made possible by emerging technologies. Ultimately, there are many different concepts for improving light force capability. RFPT research has, so far, explored two different concepts to improve light forces: improved direct fire and improved indirect fire through hunter–standoff killers.

An important avenue for enhancing light force capability is to improve its *direct-fire* weaponry. In this area, new technologies are already playing a role. For example, sensor technologies can be used to increase the range of detection and acquisition, new information-processing technologies and automatic target-recognition methods can be used to reduce fire cycle times, and weapons technologies can be used to increase range, accuracy, lethality, and rates of fire.

Another means for improving a light force is to improve its *indirect-fire* capability, such as through the hunter–standoff killer concept mentioned above. That is, instead of emphasizing the force's ability to fight "toe-to-toe" in the direct-fire battle, this concept shifts the focus to the indirect-fire battle. The RFPI is largely made up of this hunter–standoff killer concept, which involves separating the target-engagement cycle into two distinct components: A distinct "hunter" system detects, acquires, tracks (if needed), and hands off target information to a distinct "killer." The hunter can be placed in relatively inconspicuous spots on the battlefield (performing relatively "silent" or passive detections without producing highly visible firing signatures), while the killer can be positioned relatively far back and out of the LOS of the targets. An entire suite of technologies is emerging that can enable this concept (some of which are already envisioned for improving the direct-fire capability).

Figure 3.3 shows the exemplary components of the hunter–standoff killer concept. Hunters—manned and unmanned, air or ground, and mobile or stationary—sense the presence, position, and status of enemy systems. They communicate the intelligence and targeting data to C2 nodes, which quickly match targets to weapons based on range, availability, and effectiveness. Killers—ranging from mortars to cannons to missiles—fire different types of munitions at the targets. Battle damage assessment (BDA) may sometimes be done by the hunters and possibly the weapons themselves. Global positioning system (GPS) technology can be used extensively throughout the force for positioning and navigation.

Candidate and Potential RFPI Systems

Focusing on the hunter–standoff killer concept, the RFPI examined a wide range of manned and unmanned reconnaissance, surveillance, and target acquisition (RSTA) assets, C2 systems, direct-fire weapons, indirect-fire weapons, obstacles, multifunction weapon systems, and self-protection systems. Table 3.1 provides a list of the systems, both the candidate ones and—since the list of RFPI systems varied rapidly with research, development, testing, and analysis of new concepts—other systems that were

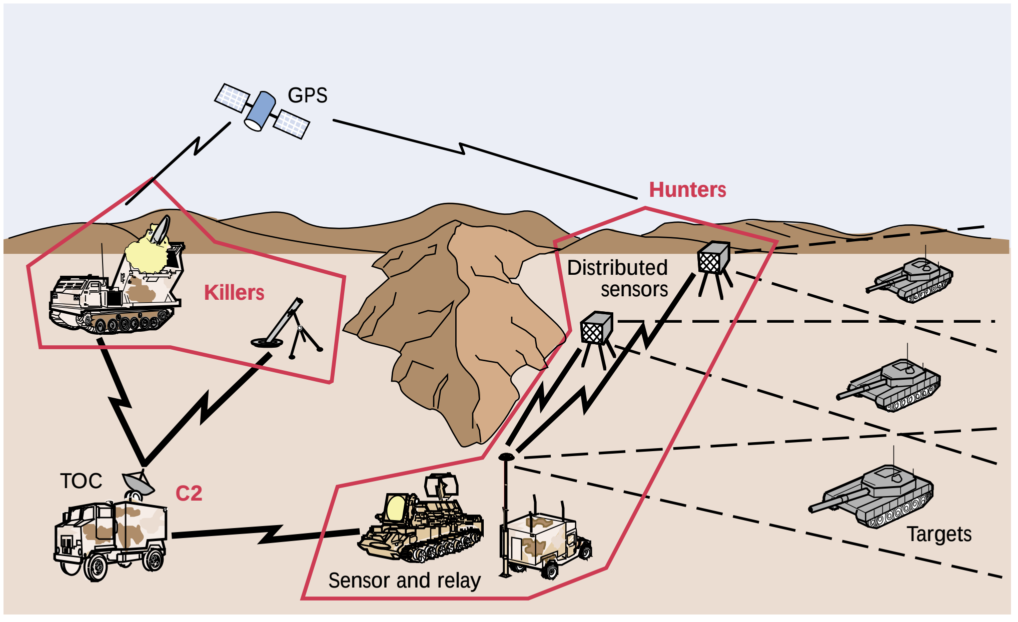


Figure 3.3—Depiction of the Hunter–Standoff Killer Concept

also of interest to RFPI, referred to as potential systems. The candidate systems were those assessed in either live or virtual experiments in the ACTD. Images of many of the key systems are included in the text below, but Appendix C provides a much more comprehensive set of images of the systems and renderings of potential ones, along with other information about the corresponding systems.

RSTA. Because the hunter–standoff killer concept relies on comprehensive and discriminating sensing, the RFPI suite of systems comprises a wide range of manned and unmanned, ground and air, and imaging and nonimaging RSTA components. Candidate systems begin with the Hunter vehicle, a HMMWV-based, target-acquisition system; this four-ton vehicle with a crew of two uses an advanced sensor suite on an extendible mast and can be equipped with a reduced-signature package. The reconnaissance, surveillance, targeting vehicle (RST-V) is a more advanced, lighter variation of the Hunter scout vehicle.

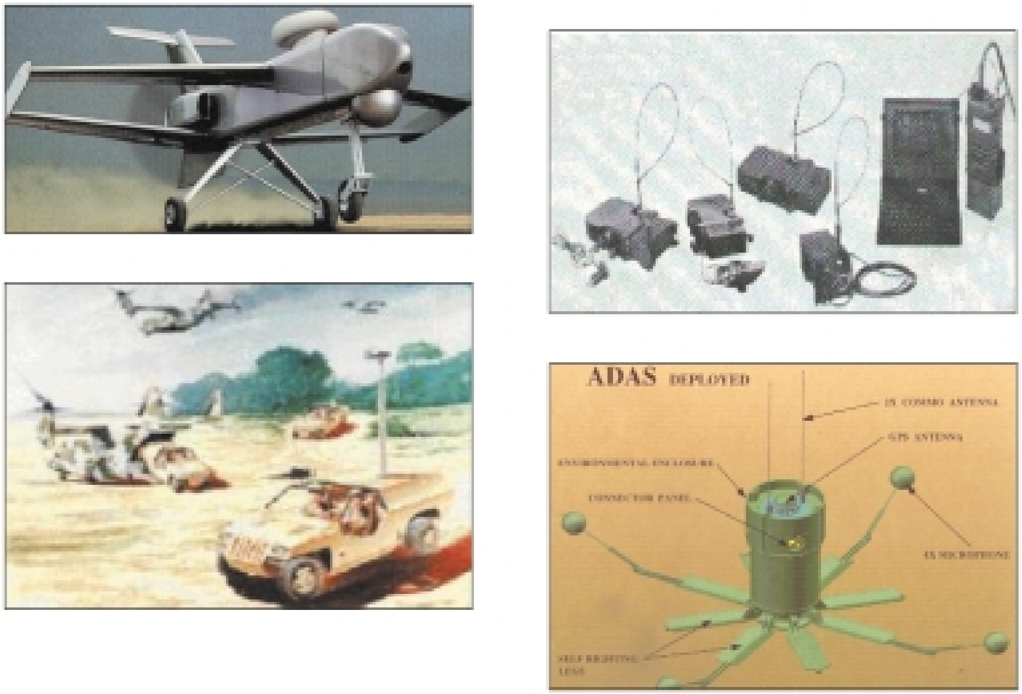
Unmanned sensors include unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and unattended sensor nets, which are simply deployed and turned on. UAVs include such systems as the small (6-foot wingspan) expendable drone (EXDRONE) and the larger (20-foot wingspan) Hunter aircraft. Both of these can carry FLIRs, video cameras, GPS receivers, and video communication links, although the larger aircraft allow larger payloads and longer flight times. Both the improved remotely monitored battlefield sensor system (IREMBASS) and remote sentry are stationary unmanned, distributed ground sensors.

Table 3.1—Candidate and Potential RFPI Systems by Function

Function	Systems	
	Candidate	**Potential**
RSTA (Saudi Arabia) (reconnaissance, surveillance, target acquisition)	• Hunter vehicle • Unmanned aerial vehicle (UAV) • Improved remotely monitored battlefield sensor system (IREMBASS) • Remote sentry • Air-deliverable acoustic sensor (ADAS)	• Video imaging projectile • Unmanned ground vehicle (UGV) • Joint surveillance target attack radar system (JSTARS)
C2 (command and control)	• RFPI C2 • Light digital TOC	• RFPI C2 excursions
Direct fire	• Javelin • Armored gun system (AGS) • AGS with line-of-sight antitank (LOSAT)	• Comanche/Longbow • Smart target-activated fire and forget (STAFF) • Guardian/directed energy
Indirect fire	• Precision-guided mortar munition (PGMM) • Lightweight 155mm howitzer • High-mobility artillery rocket system (HIMARS) – Sense and destroy armor (SADARM) – Damocles	• Precision multiple-launch rocket system (MLRS) • Army tactical missile system (ATACMS) • Brilliant anti-tank (BAT) submunition • Smart 105mm
Obstacles	• Wide area munition (WAM)	
Multifunctional	• Enhanced fiber-optic guided missile (EFOG-M) • Intelligent minefield (IMF)	• Hydra (obstacle)
Self-protection		• 3rd generation smoke

The air-deliverable acoustic sensor (ADAS) is a five-microphone sensor system, built by Textron Systems Corporation, that can locate, track, and, to some extent, classify enemy vehicles over large areas by using their acoustic signatures. Modeling of this system is described below in the after-action review section of this chapter.

Potential RSTA systems include the video imaging projectile, a 155mm artillery round that ejects a video sensor on a parafoil, which can be used to survey a location before committing an artillery barrage. UGVs such as the 1-ton MDARS vehicle or the 4-ton robotic HMMWV might be used to deploy or reposition ground sensors, mines, or other weapons, with special applicability in high-risk areas. Improved versions of the joint surveillance target attack radar system (JSTARS) may be available to the light force for long-range surveillance and targeting. Images of some of these systems are provided in Figure 3.4.



IREMBASS image courtesy of U.S. Army CECOM. RST-V rendering courtesy of Defense Advanced Research Projects Agency.

Figure 3.4—Some Light Force RSTA Systems: Tactical UAV, IREMBASS Distributed Sensors, RST-V Platform, and ADAS

Command and control. The RFPI C2 system was envisioned to be a networked set of C2 nodes with automated routing and decisionmaking overseen by human operators; it would rely mostly on SINCGARS links for connectivity. The potential RFPI C2 excursions may include additional networks, decision aids, and automation; these were envisioned to be incorporated into a system referred to as the light digital tactical operations center (LDTOC).

Direct-fire weapons. Candidate RFPI direct-fire systems included a wide range of infantry, light vehicle, and medium-weight vehicle systems. These included Javelin, which is a short-range shoulder-fired anti-tank guided missile, the 18-ton-plus Armored Gun System (AGS), which is a light tank with a 105mm main gun, and Line-of-Sight Antitank (LOSAT), which is a kinetic energy missile (KEM) that can be fired from pods, replacing the main gun turret. At the time the RFPI analysis was conducted, the Army was still seriously considering introducing AGS to replace the M-551 Sheridans, which were then still present in the 82nd Airborne Division or (later) XVIII Airborne Corps.

Rotary-wing armor killers include the Apache attack helicopters and OH-58 scout helicopters. Alpha-model Apaches and the OH-58s employ direct-fire laser-guided Hellfire missiles. Potential future direct-fire systems include Comanche, the RAH-66 low-observable scout-reconnaissance helicopter that is scheduled to replace portions of

Images courtesy of ASA(ALT).

Figure 3.5—Some Direct-Fire Weapons: Javelin, AGS, LOSAT Missile, and Apache (Firing Hellfire)

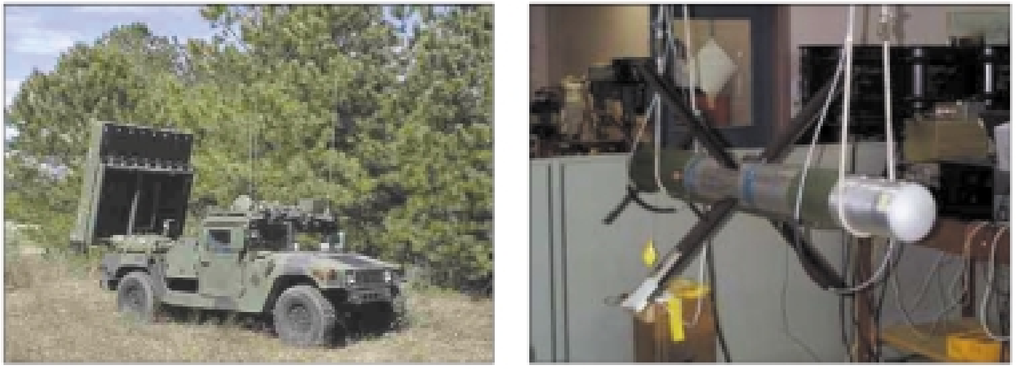
the AH-64 and OH-58 force. It carries a long-range, fire-and-forget millimeter-wave (MMW) radar-guided missile or laser-guided Hellfire missiles. The new Apache D models also use the Longbow version of the missile. Another potential system is the smart target activated fire and forget (STAFF), which is a medium-range, top-attack, tank-fired smart round which would extend the range of the AGS. An even farther-out future concept is a notional laser beam weapon–carrying vehicle.[2] Some examples of direct-fire weapons are shown in Figure 3.5.

Indirect-fire weapons. Candidate indirect-fire weapons include precision-guided mortar munitions (PGMM), the lightweight 155mm howitzer (LW-155), and the high mobility artillery rocket system (HIMARS). PGMM consists of an 81mm or 120mm mortar round with a semi-active laser (SAL) for terminal homing and either an infrared (IR) or MMW for autonomous target acquisition. LW-155 is a towed, helicopter-liftable 4.5-ton howitzer able to fire rounds with sense and destroy armor (SADARM) submunitions, smoke, illumination, and many other rounds. The high mobility artillery rocket system (HIMARS) is a 14-ton wheeled vehicle (based on a 5-ton truck chassis) carrying a pod of six multiple-launch rocket system (MLRS) rockets, which could be loaded with dual-purpose improved conventional munitions (DPICM), SADARM, or Damocles munitions (described in Appendix C). Many of these smart munitions may benefit from GPS or inertial guidance. A conceptual addition to these developmental systems is the Smart 105mm, a very lightweight howitzer firing a submunition with a large footprint and shaped-charge lethal effects. Some examples of these indirect-fire systems are shown in Figure 3.6.

Obstacles. The one candidate obstacle is the wide area munition (WAM), which is used as an autonomous obstacle, capable of engaging combat vehicles out to a 100-meter range. This system uses a small microphone array to detect nearby armor vehicles and lofts a Skeet-like munition over the target in the direction of nearest approach.

Images courtesy of Fort Sill.

Figure 3.6—Some Indirect-Fire Launchers and Submunitions: ATACMS and MLRS, BAT Submunition, Towed 155mm Howitzer, HIMARS, and SADARM Submunition



Images courtesy of the Enhanced Fiber Optic Guided Missile Project Office, Redstone Arsenal.

Figure 3.7—Fiber-Optic Guided Missile and Launcher

Multifunctional systems. Multifunctional systems can act as both sensor and weapon. Candidate systems include the enhanced fiber-optic guided missile (EFOG-M), a 15-kilometer range missile with a GPS antenna/receiver onboard and an imaging sensor in the nose that sends back video to the operator along a fiber-optic link. Six EFOG-M missiles are mounted on a HMMWV platform (see Figure 3.7). This system flies slower and has a longer time of flight than the other indirect-fire systems, but it has a very high level of delivery accuracy and a large munition footprint because of its man-in-the-loop imaging and control. EFOG-M is especially applicable to the future battlefield because it can engage both stationary and moving vehicles and slow-moving helicopters.

A second multifunctional system is the intelligent minefield (IMF). This complex ensemble of systems is envisioned to leverage acoustic information from WAMs and other acoustic sensors. Improvements over WAM include a gateway for transmitting contacts back to a manned station, along with the rules for engaging targets and coordinating attacks. The acoustic information is combined ("fused") and used to better engage targets both by the minefield and through coordinated attacks with other systems. An exploratory system (by Aerojet) is the Hydra, a low-cost addition to the IMF, consisting of an inexpensive commercial video system boresighted to an explosively forged penetrator (EFP), which is connected to, and controlled by, an operator console through the use of fiber-optic lines. With the video capability, this system can also provide overwatch and detonation of a conventional minefield (e.g., claymore mines).

Self-protection. In this category, only one system of relative near-term technologies was examined: 3rd generation smoke, an obscuring agent with the reported capability of occluding visible, IR, and MMW signals. The primary problem with this system appears to be the ability to keep the hot and variably sized smoke particles aloft long enough to be effective.

The concepts and technologies we model in the rest of this chapter are drawn from those discussed above.

Options for Improved Light Forces in the Three Scenarios

To build the improved light forces, we started with the base case DRB defined in Chapter Two and systematically added various new capabilities (discussed above) to this force. First, we introduced an “improved direct-fire capability.” To represent this, we selected two key direct-fire systems that the U.S. Army was pursuing at that time—the AGS to replace the Sheridan, and the Javelin shoulder-fired anti-tank missile to replace the Dragon.

Second, we built on this improvement by adding a representative “hunter–standoff killer” capability to the DRB. To represent this upgrade, we selected a reduced-signature hunter vehicle (with mast-mounted sensors) and the enhanced fiber-optic guided missile (EFOG-M). These two systems work as a team, with the forward-positioned hunter vehicle acquiring targets and handing them off to the more safely positioned EFOG-M platform. (Refer back to Figure 3.3 for an illustration of the concept.)

Finally, we further altered the force by streamlining the hunter–standoff killer with “fast C2.” Essentially, the RFPI envisions using an improved C2 system, based on the U.S. Army light tactical operations center (TOC). Although at the time of this work the architecture had yet to be defined, we were able to simulate the effect of one key parameter—the time it takes to hand off target information between hunter and standoff killer—by halving the C2 delay time between hunter and standoff killer.

Table 3.2—Base Case and Improved DRB Force Mix for the Three Scenarios

Scenarios	Blue Forces: Blue Case DRB	Blue Forces: Upgraded DRB	Red Forces
SWA	15 HMMWV-Scouts **54 Dragons** 18 Stingers 6 Apaches **14 Sheridans** 8 M198s **58 HMMWV-TOWs**	15 HMMWV-Scouts **54 Javelin** 18 Stingers 6 Apaches **14 AGS** **18 HMMWV-TOWs** **24 Hunter** **18 EFOG-M**	323 T-72S (tanks) 219 BMP-2 (APCs) 35 BTR-60 (APCs) 30 120/180 MRL (rocket artillery) 72 152 SPH (cannon artillery) 16 HAVOC/HIND (helicopters)
East Europe	Same as above	Same as above	Same as above
LANTCOM	**34 HMMWV-TOWs** 4 AGS 24 Javelin 6 Apaches 8 155mm howitzer 18 105mm howitzer 18 forward observers 2 UAV	**13 HMMWV-TOWs** 4 AGS[a] 24 Javelin 6 Apaches 8 155mm howitzer 18 105mm howitzer **12 EFOG-M** 18 forward observers 2 UAV **6 Hunter** **18 Remote sentry** **36 Overwatch sensors**	131 T-72S 131 BMP-2 6 120/180 MRL 12 152 SPH 6 HAVOC/HIND

a At the time the analysis was conducted, systems like the Sheridan were still integral to the 82nd Airborne’s DRB. In addition, the Army was considering introducing the AGS as a replacement for the Sheridan, plus elsewhere in the force structure.

The force mixes have been changed to reflect these improvements made to the Blue light forces, with the Red forces remaining as they were in the base case. Table 3.2 shows the new force mixes for the three scenarios. The boldface elements reflect changes from the base case shown in Table 2.2.

In building the "enhanced DRB," we assume that the airlift is fixed. In other words, only about 4,300 tons of equipment can be airlifted within the requisite deployment window, regardless of the composition of the equipment. This is because the resources available to deliver the light airborne forces are also assumed to be fixed, with approximately 108 sorties (54 C-5s and 54 C-141s) being required to move the current DRB into theater and 37 C-141s required per day for resupply (Steeb et al., 1996a).

Thus, when the different specific DRB upgrade options are added—in this case, direct fire, hunter–standoff killer, and fast C2—we examined what must be traded out, which is reflected in Table 3.2. For the direct-fire systems, it is essentially a one-for-one swap. For every AGS added to the force, one Sheridan is removed, and for each Javelin added to the force, one Dragon is removed, as shown in the table. In incorporating systems associated with the hunter–standoff killer, it is not as clean a swap. Only some of the HMMWV-TOWs are swapped out for a precalculated ratio of Hunter vehicles and EFOG-M platforms. We assumed that the fast C2 concept did not require any additional hardware, so there was no airlift change associated with this last upgrade.

Experiencing Desert Storm II: Upgraded DRB

THE LIEUTENANT KNEW FROM HIS ADVANCED INTELLIGENCE ASSETS that an artillery attack was likely. When the first artillery shell exploded, he knew it signified the opening round of a battle that his DRB would finish. After all, they had just completed extensive training with a new engagement concept along with the latest in weapons technologies. The concept, called ***hunter–standoff killer****, would allow the DRB to effectively extend its reach many times over the more traditional direct-fire battles they had practiced just a few years ago. Instead of engaging the massed armor when his men were vulnerable to enemy return fire from a few kilometers out, they were now armed with missiles linked by fiber optics that could be "flown" out as much as 15 kilometers to engage the enemy's tanks. The lieutenant knew that because the missile trajectory was "nonballistic," the enemy could not backtrack it to its launcher and guide counterfire back in. This would be the first time the EFOG-Ms would be used in battle, and the first time his men would fire one outside of a training exercise.*

In addition to the EFOG-Ms, the DRB was equipped with precision-guided weapons, smart enough to search and engage enemy armor by themselves. Some of these weapons were delivered by mortars, some by towed artillery, and some by the new HIMARS via the MLRS rockets. The MLRS rockets were loaded with smart munitions called Damocles that would greatly improve the effectiveness of each volley. To provide the needed "eyes" to cue the various weapons, a wide range of *both manned and unmanned sensor systems were positioned forward, with both Army helicopters and some USAF aircraft.*

As the battle began with the first barrage of enemy artillery fire, the DRB answered with counter-battery fire using both the new smart 155mm sense and destroy armor (SADARM) submunitions and HIMARS with Damocles. Both of these weapons had proved in recent operational testing to be at least an order of magnitude more lethal than DPICM and HE rounds. Aware of this capability, the enemy artillery attempted to overcome the counterfire by operating in a very fast "shoot-and-scoot" cycle, firing and then moving in a few minutes to a new position. Although such tactics gave the enemy some survivability against smart and dumb rounds, they also slashed the total volume of fires it could put on the DRB location: the enemy artillery would start to fire but then quickly stop, resulting in disparate volleys of relatively short duration.

Although the DRB's counterfire soon subdued the enemy's artillery, it did not stop the ground maneuver, which was now under way. With all of the recent improvements in RSTA, the DRB now knew with certainty where the enemy was located at any given time—not just the general direction of the attack, but the size of force components and movement of the enemy's vehicles. This detailed knowledge allowed the lieutenant's battalion commander to inform and prepare the rest of the unit well in advance of the attack. And while this information, by itself, would provide some benefit, when combined with the DRB's precision it would allow considerably greater lethality at range.

It wasn't until half an hour after they started receiving fire that a report came through, passed down from the TACNET, that friendly air strikes were inbound. The lieutenant guessed that they were coming out of Doha. While he knew he would not be able to see them, he listened for their presence as he monitored the enemy's movement toward the DRB on his tactical display. He expected the air strike would be focused on the lead vehicles in the attack. This would not only serve to buy more time for the DRB but would tend to demoralize the following vehicles. Shortly after it began, the air strike was over. It claimed some enemy vehicles, causing some disruption, but was nowhere near enough to stop the enemy's advance. From this point forward, the battle would belong to the DRB.

Perhaps one of the most significant improvements the DRB incorporated over the past few years was new RSTA capability. Over the past few years, a wide range of tactical sensors, including the ADAS, unmanned sensor, and the new "Hunter" scout vehicle, were incorporated into the force. As the enemy began its attack maneuver against the DRB, details on its movement were acquired by the sensor network and sent to the light digital TOC, which then seamlessly disseminated the information.

The indirect-fire battle against the armor began as soon as the vehicles moved into range of the EFOG-M platforms. Cued by the ADAS sensor network, which covered the DRB's sector as far out as 20 kilometers, EFOG-Ms were launched as the enemy formation moved into range. The first information the lieutenant received indicated the attack was initially occurring to the northwest. These forces would be engaged by Alpha Company's EFOG-Ms. Although information sent through SINCGARS indicated that the first wave of EFOG-Ms were successful, the sheer number of enemy vehicles overwhelmed them. Observers also reported that the enemy's APS recently installed on their T-72s were managing to destroy some of the EFOG-Ms as they engaged. As the enemy continued to advance, the lieutenant re-

ceived a report from his "hunters" (i.e., two different sets of ADAS systems were providing the direct cues for his company) that five heavy-tracked vehicles had entered the target area of interest (TAI). His platoon responded.

The lieutenant's platoon immediately engaged the lead vehicles. As he had practiced many times before, he quickly plotted the waypoints for his EFOG-M attack. He then ordered two missiles fired in quick succession. Once both of them were up and on their way, the gunner opened the camera on the lead missile. The weapon was flying at relatively low altitude but was moving at 100 meters per second (about 280 miles per hour). As it flew, the gunner correlated the images he saw through the camera with the missile locator on his control panel. It was interesting to see the missile automatically turn at each waypoint, using GPS for guidance. As both missiles reached the target area the gunner could now see the enemy vehicles, their image transmitted from the camera on the nose of the EFOG-M through the fiber-optic cable to his control station. At this point, he took over the missile's flight controls, lining up boresight directly on the lead vehicle. As the missile neared, he could confirm that the target was indeed a T-72. He kept the missile pointed directly at the vehicle until impact. Then he switched the control panel to show the second missile's camera, which was now approaching the target area. From its transmitted image, he could confirm that the first missile successfully engaged the lead tank. The gunner aimed the second missile at the next T-72.

The lieutenant heard through his SINCGARS that the Apache mission was ready to go, but he fired more missiles and would continue to do so as long as possible. They had practiced joint attack operations while at the NTC. In this case, the EFOG-Ms and Apaches would have to share the same airspace, since they were engaging the same target set. The missiles led, with the Apache attack not far behind. Because the EFOG-Ms not only reduced the total number of enemy systems (including air defense) but also caused considerable disruption, the Apache mission was executed with great success. Most of the Hellfires launched found their targets, resulting in kills of over 60 enemy vehicles, although one Apache was lost to the enemy air defense network.

Down to their last two missiles, the platoon fired them as the Apaches began their withdrawal. At this point in the battle, the information flow through SINCGARS indicated that the enemy had sustained significant losses but was continuing its attack. The surviving enemy vehicles had now moved within 5 kilometers of the DRB and were about to be engaged by the HMMWV-mounted TOW missiles. These systems had good fields of fire with the flat and featureless terrain. In addition to the HMMWV-TOWs, the enemy was now encroaching into direct-fire range, and the Javelin gunners would soon be joining the fight. Unlike the old Dragons, the Javelins could fire at ranges much greater than that of the machine guns on the approaching tanks. Additionally, the Javelin gunners were able to move as soon as they fired, since the weapons were fire-and-forget, another big difference from the slow, short-range Dragons that had to be guided all the way to the target. As the carnage of the direct-fire battle continued, the enemy began to fragment; the lieutenant could see the remnants of enemy companies dashing for what cover was available rather than continuing to advance. It was evident that the DRB would succeed in its mission to defend the critical road junction, protecting the oil fields to the south and establishing the entry point for follow-on U.S. heavy forces.

After-Action Reports

Unlike in the base case SWA scenario, we see that with the near-term incremental upgrades shown in Table 3.2, the outcome is considerably more favorable: *The DRB was able to repel a much larger, current-generation heavy force.* Is this true for all three scenarios? In addition, how did the various improvements to the DRB contribute to its performance? To answer these questions, we now examine (as we did in Chapter Two) the modeling and simulation results for the three scenarios for the three cases in terms of some key outcome measures.

After-Action Reviews for the Three Scenarios: Base Case Versus Upgraded DRB

When we examine the LER for the two bounding cases of terrain, SWA (representative open terrain) and East Europe (representative close terrain), it is apparent that the upgrade options described above—improved direct-fire capability, hunter–standoff killer capability, and fast C2—provided considerable improvement to the DRB. Figure 3.8 shows the respective (cumulative) improvement in LER obtained by the three different upgrade options compared to the base DRB at the same time in the battle, 58 minutes into the simulation. While in the base case DRB the LER was not good enough to result in a successful defense against the Red force, the DRB with the enhancements was able to decisively stop the attack in the SWA scenario and marginally fight to a draw in the East Europe scenario.[3]

Notably, the addition of just the direct-fire upgrades (AGS and Javelin) improved the force, but not enough to turn the tide. It was not until the hunter–standoff killer

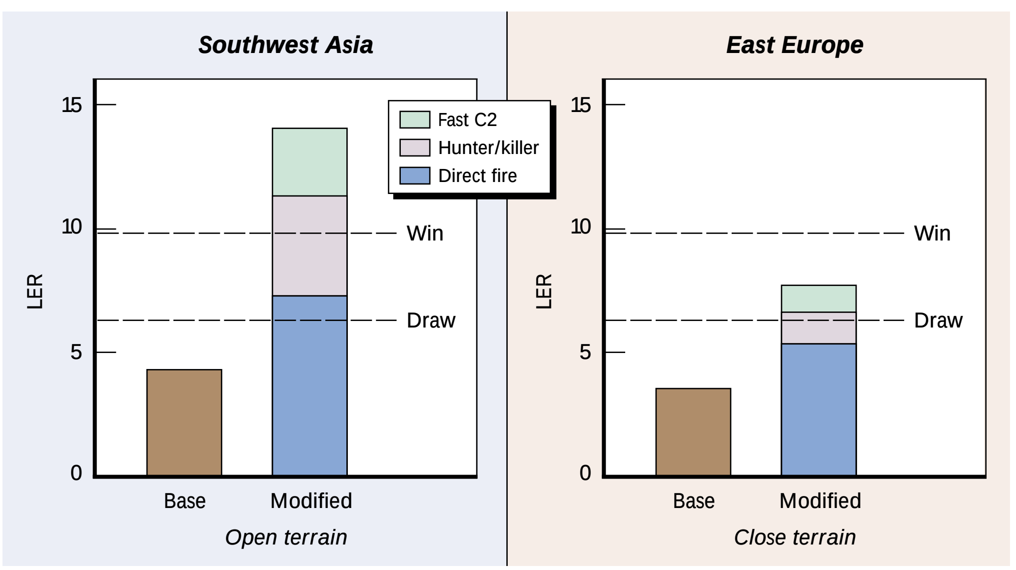


Figure 3.8—Effect of Upgrades on LERs in SWA and East Europe Scenarios

concept (hunter vehicle and sensor suite with EFOG-M) was introduced that a winning LER could be achieved in SWA and a draw in East Europe.

Figure 3.9 shows the improvement to the LER over time from the upgraded DRB (the brown lines) compared with the base case LER curves shown before (the blue lines). In the SWA scenario in particular, the LER was actually as high as 30 at the end of the indirect-fire battle. The contribution of the hunter–standoff killer systems in this scenario is very evident—the battle, as far as the DRB was concerned, could start much sooner and could be waged at much longer ranges, well before the main force became susceptible to Red's direct-fire assets.

Although not as dramatic, the impact of the hunter–standoff killer systems in the East Europe scenario is still quite evident. The LER improved by a factor of two leading into the direct-fire battle. In the LANTCOM scenario (here with EFOG-M forward), Blue begins with a high LER because of EFOG-M kills. The upgraded DRB then moves into the direct-fire phase with a much more favorable force ratio than was present with the baseline DRB.

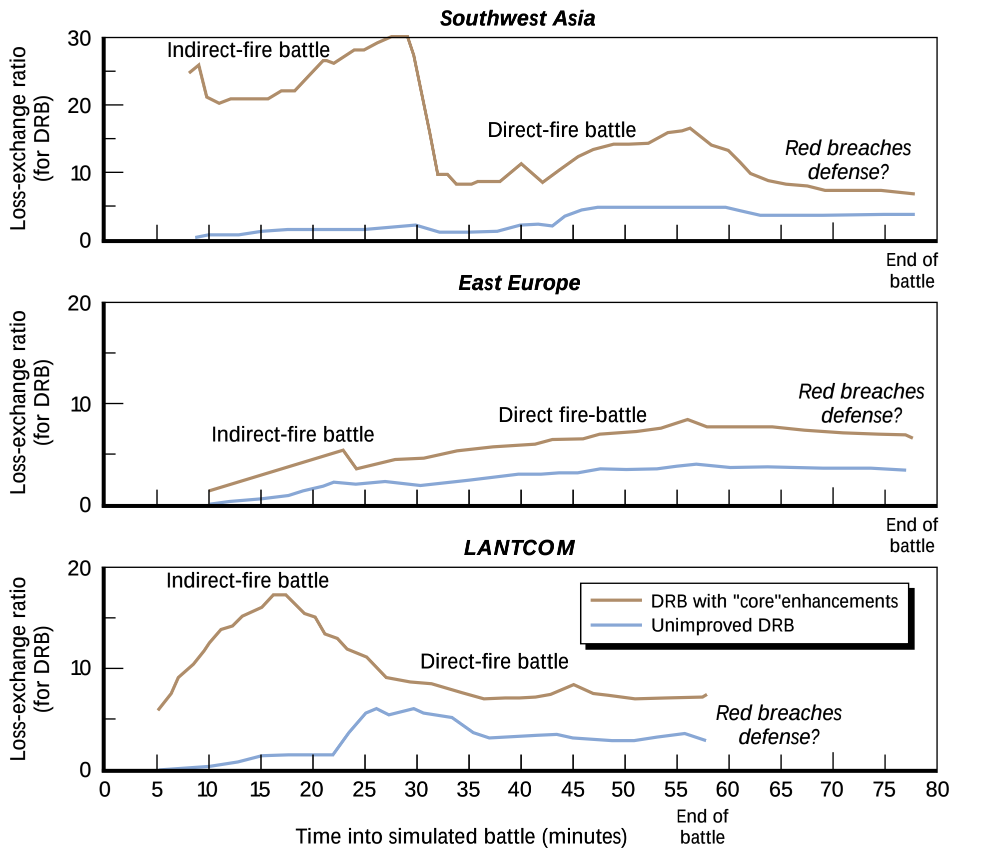


Figure 3.9—LER Over Time for the Three Scenarios: Upgraded DRB

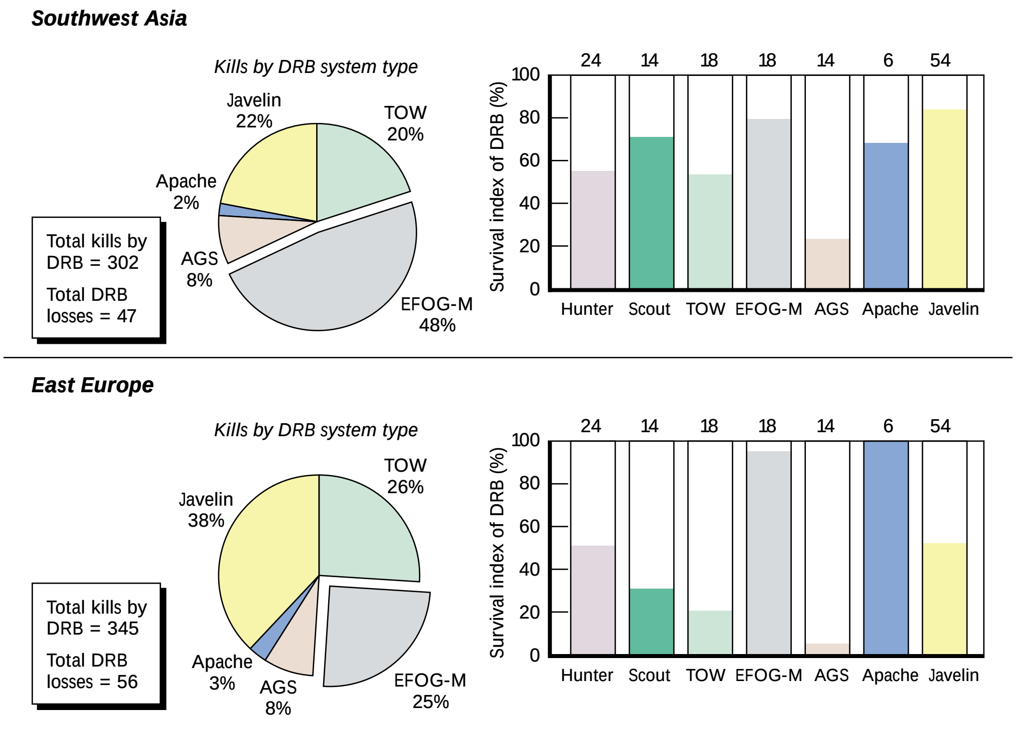


Figure 3.10a—Simulation Results at the End of the Battle for SWA and East Europe Scenarios: Percent of Elements Left

Figure 3.10a shows the outcome of the simulated battle for the SWA and East Europe scenarios in terms of percent of Blue capability remaining (although we envision that Red would probably have called off the battle before breaching the enhanced DRB defensive position). Many more Red systems are attrited (302 in the upgraded case versus 247 in the base case for SWA and 345 versus 279 in East Europe); however, the survivability numbers of the DRB reveal an even more profound difference. The upgraded DRB sustained only about half the losses of the base case DRB. Unlike the base case DRB, which was mostly attrited at the end of battle, this force is still intact, particularly so in the SWA scenario.

Moreover, whereas the primary weapon in the base case was the HMMWV-TOWs, two new systems—the EFOG-M and Javelin—provide the bulk of the lethality in the enhanced DRB force. Since HMMWV-TOWs were traded out for an equal number of EFOG-Ms, we would expect that some of the HMMWV-TOW contribution would go down. However, in the SWA scenario, the EFOG-M made a proportionally much higher contribution than the HMMWV-TOW. Also notably, the Javelin, which was a one-for-one exchange for the Dragon system, provided a significantly higher share of the overall force lethality in this case. A similar outcome was seen in the mixed-terrain case of LANTCOM as well, shown in Figure 3.10b, where EFOG-M constituted over half of the total DRB lethality.

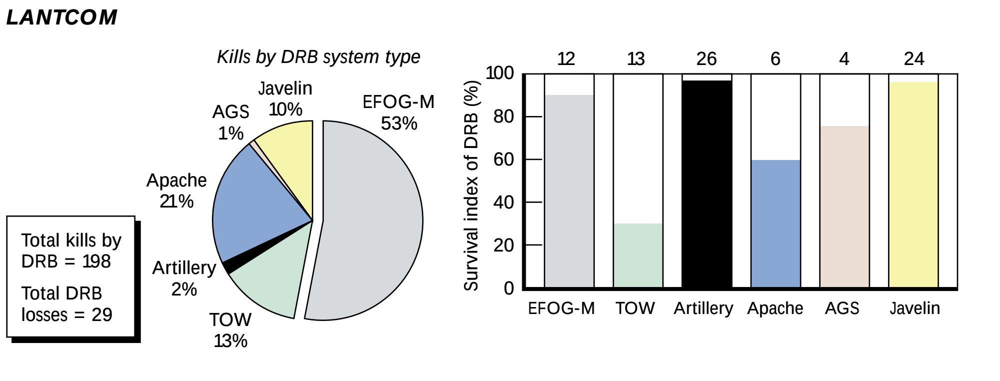


Figure 3.10b—Simulation Results at the End of the Battle for LANTCOM Scenario: Percent of Elements Left

The enhanced DRB does considerably better than the base case DRB, largely because of the hunter–standoff killer concept. This concept clearly allowed the fight to begin much earlier and from much farther away. Unlike in the base case, where the engagements were occurring within 4 kilometers of the force elements, in the enhanced case the engagements started from beyond 8 kilometers. This not only increased the window in which Red systems could be attacked, resulting in higher DRB force lethality, but also allowed for a "metering in" of the Red force to the direct-fire battle. That is, when the Red force closed, its systems were fewer in number and could more easily be managed by the DRB's direct-fire systems. *Thus, with this "shaping of the battlefield," there was improved DRB lethality accompanied by higher overall DRB survivability.*

Although the DRB upgrades led to improvement in all three scenarios, the level of improvement was quite different between the scenarios with open and close terrain. More specifically, the benefit was considerably less apparent in the close terrain of East Europe. Examining the scenario data showed that the hunter vehicle's ability to "see" was the primary distinguishing factor. That is, in the limited-LOS terrain, not only were the hunter vehicle sensor ranges much shorter, reducing the number of calls for fire from the EFOG-M platforms, the hunter vehicles also tended to be more susceptible to unexpected or "chance" encounters with the advancing enemy force.

In summary, the enhanced DRB performed as one might expect. The new direct-fire systems had higher lethality, allowing for a higher overall LER. Adding the hunter–standoff killer concept was a key enhancement that provided enough initial firepower to change the dynamics on the battlefield—greatly reducing the possibility of being overrun. Fast C2 allowed for more effective hunter–standoff killer performance; not only were more rounds delivered, they were placed with greatly reduced error (less target movement until round impact).

Although it is worthwhile to note that the enhanced DRB does substantially better than the current DRB, a few critical questions remain to be answered. Namely, what would happen if the enhanced DRB had to face a sophisticated future enemy force?

How might other advanced precision-guided weapons fare in lieu of the EFOG-M? These questions were addressed as simulation excursions; the answers to these questions are provided in the following subsections of this chapter.

Excursion: What If the Enhanced DRB Faced a Future Heavy Force?

So far, we have examined the effectiveness of the current and enhanced DRB against a current-generation enemy force. But how would this upgraded DRB perform against a *future* heavy force? Here we consider this question, using the SWA and East Europe scenarios.

Upgrading the Red threat. A future heavy force is generally defined here as a force with enhanced weapon systems, including high-tech Russian systems either currently available on the arms market or nearing the end of their development. Table 3.3 shows what we have done to improve the Red threat in terms of sensors, armor, weapons, and air defenses. The upgrades we postulated for enemy forces covered several dimensions. Improved sensors (FLIRs) were provided to all threat elements, instead of being available to just the command vehicles. Armor was improved to reflect the state-of-the-art Russian tank (T-80+ versus T-72) and armored personnel carrier (BMP-X versus BMP-2). More effective munitions supplanted their current counterparts: the longer-range AT-8 (5-kilometer missile) replaced the AT-5 (4-kilometer missile), and a smart munition referred to as the MCS-E1 (very similar to the U.S. Army's SADARM) replaced the HE artillery round. Also, very high-end air defense was provided. Generally, these high-tech systems were swapped into the enemy force in a one-for-one exchange with the old systems.

Upgraded DRB performance versus upgraded future Red heavy threat. Figure 3.11 shows that when the changes in Table 3.3 are made, a future threat force is able to significantly improve its performance against both the base DRB and the enhanced DRB. Essentially, Red is able to change the LER to where only a draw could be achieved in SWA and a loss occurs in East Europe. Although the enhanced DRB with the "core" RFPI enhancements still does considerably better than the base case DRB, the upgrades

Table 3.3—Upgrades to Red Threat

Dimensions	Current	Upgrade
Sensors	FLIRs to command vehicles only	Improved FLIRs to all threat elements
Armor	Tanks: T-72 BMPs: BMP-2	Tanks: T-80+ BMPs: BMP-X
Weapons	Antitank: AT-5 Rocket artillery: HE	Antitank: AT-8 Rocket artillery: MCS-E1
Air defenses	SA-8	SA-15, plus SA-19 (as part of 2S6 system)

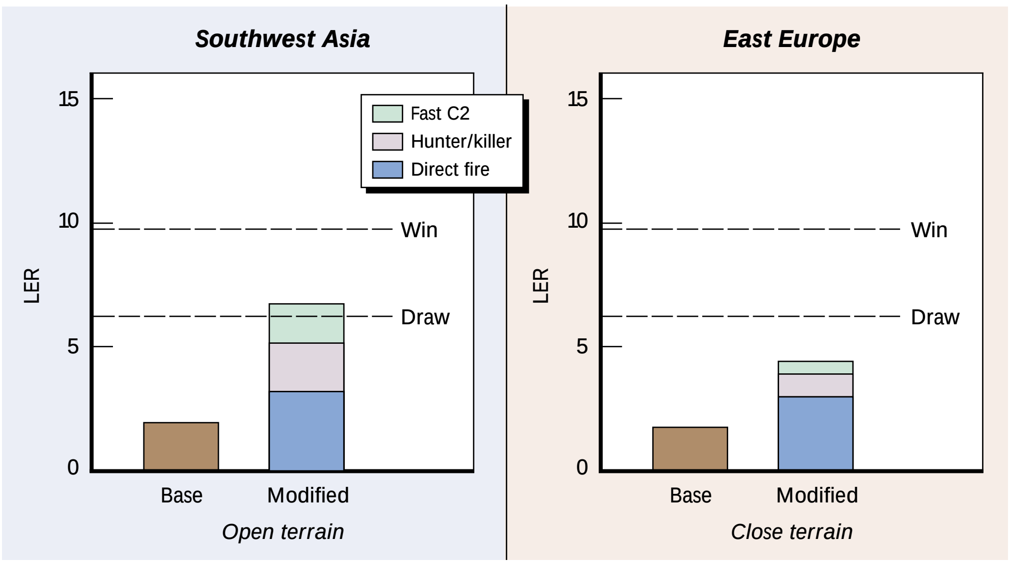


Figure 3.11—Effect of Red Upgrades on LERs in SWA and East Europe Scenarios

are not sufficient to accomplish the stated force objective—repel the attacking Red force—especially so in East Europe.[4]

Why doesn't the base or enhanced DRB fare as well against the future threat? First, the improved threat sensors allowed earlier detection of Blue's forward-based scouts and hunter vehicles. Early DRB losses of these systems translated to less situation awareness and a significant reduction in calls for indirect fires.

In addition to the loss of the "eyes" on the battlefield, which reduced the amount of Blue indirect fire, the Red systems were more capable in the direct-fire battle. Red's improved sensors, in conjunction with its longer-range missiles, greatly reduced the DRB's close combat advantage. The Red force was able to fight on a level closer to parity, and the LER was effectively reduced from around 4:1 down to 2:1.

Also, the addition of the smart artillery munition proved to be effective against the DRB. Even though such "first-generation" munitions as the MCS-E1 do not have a very large footprint, the DRB systems were still susceptible to these weapons because they are relatively stationary.[5]

Improving the enhanced DRB to counter the future heavy threat. Given this result, we made some improvements to the upgraded DRB, adding additional RFPI systems to the force. For possible RSTA improvements, we considered two "unmanned" systems, the remote sentry (FLIR with acoustic cuer) and a UAV (based on a close-range concept such as the CL-227 Sentinel). Additional direct-fire upgrades we examined included a kinetic energy missile (with relatively fast firing rates) for the AGS. We examined the impact of WAM. And we also assessed the impact of augmenting the force with other indirect-fire systems, including shorter-range (relative to other indirect-fire systems) PGMMs and longer-range rocket artillery (HIMARS) with MLRS rockets containing

SADARM. As mentioned before, all these adjustments were made assuming constant airlift, where swap-outs of current DRB counterpart systems were made as necessary to the DRB; for example, adding HIMARS required some of the towed howitzers to be removed from the force. (See Table 3.1 and discussion for a description of these systems.)

Results for both scenarios. Figure 3.12 shows the impact each RFPI system makes to the upgraded DRB LER. We found that most systems can provide at least some further improvement to the LER, but these tend to be relatively incremental improvements at best. The UAV did not survive in East Europe against radar-guided air defenses. The short-range PGMMs were competing with the direct-fire systems and consequently did not provide meaningful improvement to the LER. HIMARS as an individual system traded in to the DRB was seen to be effective in SWA, but it was not assessed in East Europe because there were not enough sightings of company-sized targets by the hunter sensors to call for this type of massed fire.

It is important to make the distinction that some systems come to the DRB with little or no airlift cost. For example, the remote sentry, the LOSAT missile, and WAM provided improvements without mandating a major swap-out. Other larger and heavier systems had to be "traded in," replacing other DRB systems. Thus, some systems should intuitively offer improvement, while others could increase or decrease the overall LER. Interestingly enough, when all the listed systems are included in the simulation (the combined bars in the figure), there was a complementary improvement to the overall LER. One example of this: WAM slows down the Red force and presents more opportunities for the other Blue indirect-fire weapons to engage the force from afar. The

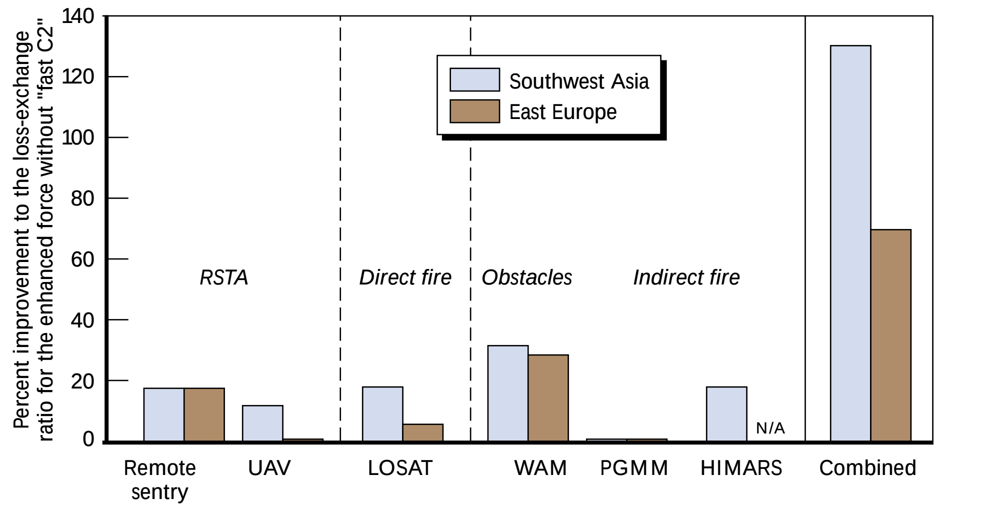


Figure 3.12—Effect of Additional DRB Upgrades on LERs in SWA and East Europe Scenarios

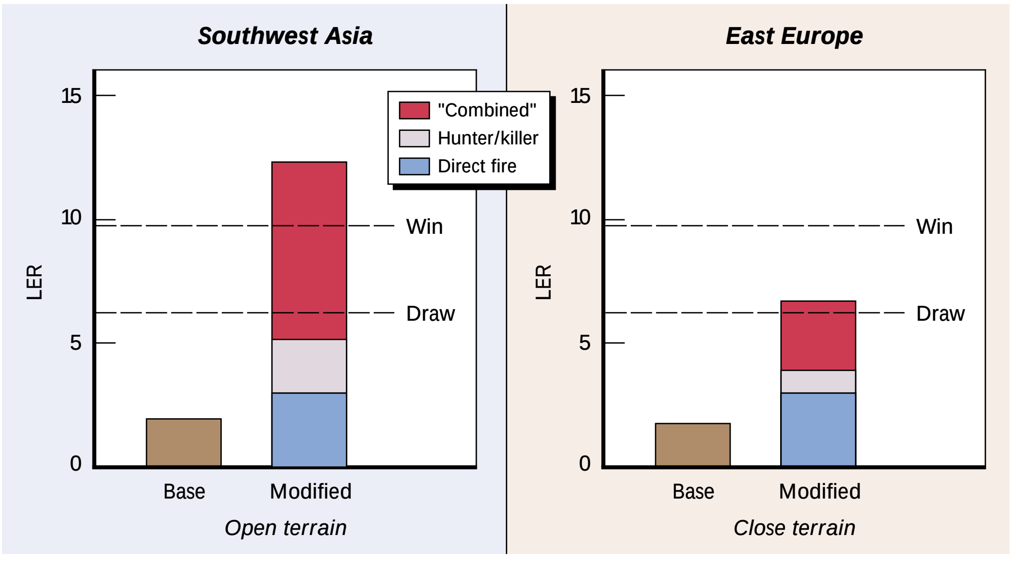


Figure 3.13—Effect of Combined Strategy on LERs in SWA and East Europe Scenarios

end result is improvements of around 140 percent in the SWA scenario and around 80 percent in Eastern Europe

Figure 3.13 shows the effect on the LER from employing the combination of the aforementioned RFPI systems (with improved direct fire and hunter–standoff killer systems). In the SWA scenario against a future threat, the combination of systems provided enough improvement to the LER to offer a win, with an LER of 12.5 at the end of the close battle. Although there was considerable improvement to the LER in the East Europe scenario, it was only barely enough to achieve a draw. For this scenario, we explored other means for achieving a win.

Improving results in the East Europe scenario. Two reasons were identified for the inability of the DRB, even with the combination of RFPI systems, to achieve a win in the East Europe scenario (with the hunter–standoff killer system providing substantially less benefit than expected). First, the added smart munitions were not exploitable because their relatively small footprints (75-meter radius in this case) were unable to effectively "encounter" mobile targets in a dispersed attack formation. Although directly related to the quality of the RSTA available in this scenario, a larger-footprint munition that could better "seek" targets might have provided a means for ensuring an encounter with the combat elements of the attacking force.

The second reason why the "combined" DRB did not win was directly attributed to sensor availability. The postsimulation analysis showed that most of the forward-positioned sensors (manned hunter vehicles, remote sentries, and UAVs) did not survive throughout the engagement in East Europe. So even though the situation was target rich, the DRB was unable to fully capitalize on its indirect-fire systems.

To examine these possible shortfalls, we postulated the following improvements to the DRB: (1) add in a larger-footprint submunition (3x radius) to increase the probability of "encounter," and (2) add in a large (300-element) distributed sensor net.

In terms of the latter change, the modeling was performed using a distributed sensor system called the air-deliverable acoustic sensor (ADAS).[6] Unlike the remotely monitored battlefield sensor system (REMBASS) used in the Vietnam War, which could be used to detect the presence of enemy vehicles at predetermined locations, ADAS can locate, track, and, to some extent, classify enemy vehicles over large areas by using their acoustic signatures. Compared to other sensors, ADAS can be rapidly emplaced (through either forward observers (FOs) en route to their deep positions or through helicopter delivery), has a relatively stealthy presence once deployed, can cover areas beyond LOS, and has relatively low levels of required maintenance.

In modeling the ADAS distributed sensor system, we found two key limitations: (1) an incompleteness of information and (2) a lower than expected level of accuracy during target location. Each of these limitations was a strong function of the "baseline" pattern of emplacement. We found that by modifying the laydown, mostly by adding more sensors, both limitations could be overcome. Figure 3.14 shows how changing the number of sensors overcame the incompleteness problem. As shown, doubling the number of sensors from 21 (7 sets of 3) to 42 (14 sets of 3) nearly doubled the number of total acquisitions. Tripling the number of sensors to 63 (21 sets of 3) further improved performance.

Increasing the number of sensors within the battlespace also improves the target location error (TLE), as shown in Figure 3.15. As expected, the higher density of sensors resulted in many more closer-in acquisitions, where more localized bearing lines also al-

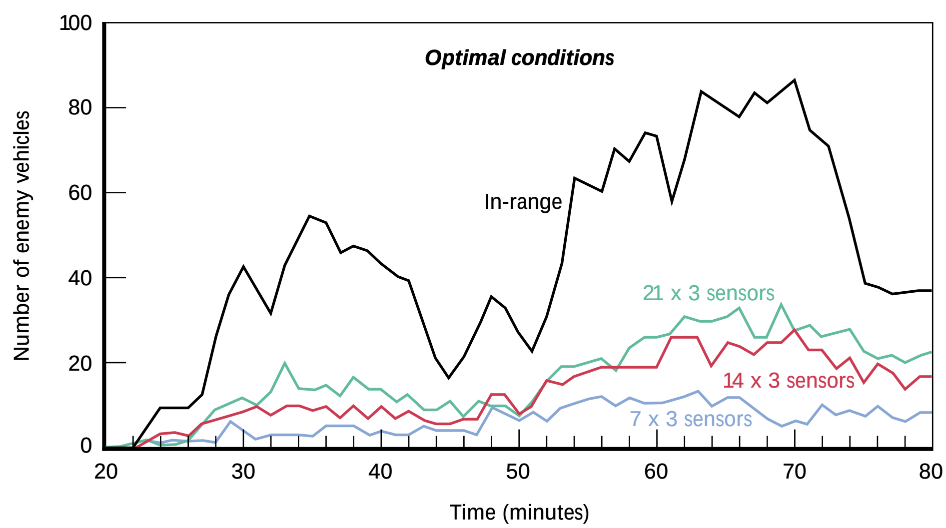


Figure 3.14—Effect of Increasing the Number of ADAS Sensors on Completeness

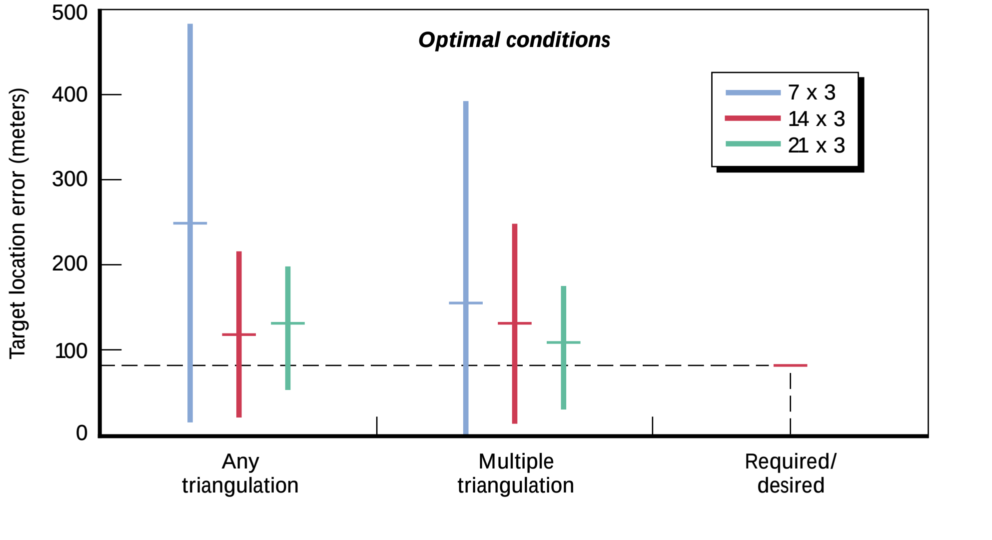


Figure 3.15—Effect of Increasing the Number of ADAS Sensors on Target Location Errors

lowed more correct correlations and closer-in acquisitions. These key improvements reduce both the average TLE and the associated standard deviation. Although the numbers of sensors assessed still does not enable ADAS to achieve the required/desired 80-meter error, the error was reduced substantially, to about 125 meters, compared to the 250- and 160-meter errors seen before.

These initial analyses suggested that acoustic sensors are a very good match with the larger-footprint weapons also modeled here. Although the required/desired levels of accuracy were not met, the larger-footprint weapon was more than adequate for successfully engaging targets.

Figure 3.16 bears this out by showing that when a full 300-element distributed sensor net and larger-footprint munitions are added to the DRB in the East Europe scenario, the DRB can improve the LER to the level of a decisive win. The figure shows the cumulative effects of first adding in the advanced artillery and then the sensor net. As it turned out, the more advanced artillery with a

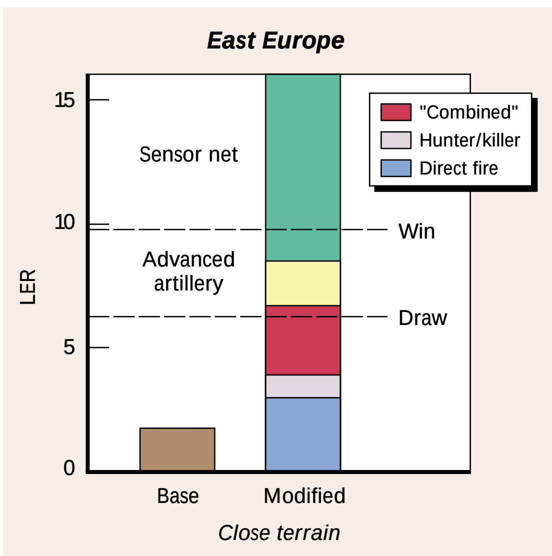


Figure 3.16—Effect of Adding in Notional Systems on LERs in East Europe Scenario

larger-footprint smart munition was not sufficient to provide a win. Rather, the lack of a good RSTA system proved to be the deciding factor. By adding the distributed sensor net, the DRB performance at the end of the close fight yielded an LER of 16.

Excursion: How Do Other Indirect-Fire Systems Compare with EFOG-M?

EFOG-M was the key advanced indirect-fire weapon system evaluated in many of the modeling runs. Given its current acquisition uncertainty and its relatively high cost per round, one natural question would be, How effective are other indirect RFPI systems compared to EFOG-M? In this excursion (which uses the LANTCOM scenario), we examine how EFOG-M performs compared with four other RFPI systems: (1) HIMARS-Damocles, (2) PGMM, (3) Smart 105, and (4) 155 SADARM, all used in the anti-armor role. (See Table 3.1 and Appendix C for descriptions of these systems.)

Figure 3.17 shows some first-order characteristics of the different indirect-fire systems. The range of the weapons varies considerably, from the shorter-range PGMM-IR and EFOG-M (15 kilometers) to the longer-range HIMARS/Damocles (40 kilometers). The ranges shown are the maximum for howitzers and mortars without rocket assistance and for MLRS rockets with a smart-munition payload. Since operationally there appeared to be value associated with attacking deep, both of the short-range systems were assessed in two ways—positioned back with the main force and positioned forward, effectively increasing their "reach" on the battlefield. (This was applied to both EFOG-M, as shown above in the analysis, and to PGMM, even though the EFOG-M because of its self-contained launch operation was envisioned to be much more capable performing in this way.)

Weapon	Maximum range	Search footprint
155 SADARM	18 km	75 m radius
PGMM-IR	15 km	500 x 500 m
Smart 105*	19 km	600 x 1200 m
HIMARS/Damocles	40 km	560 m radius
EFOG-M	15 km	1.6 km swath

*Projected system capabilities.

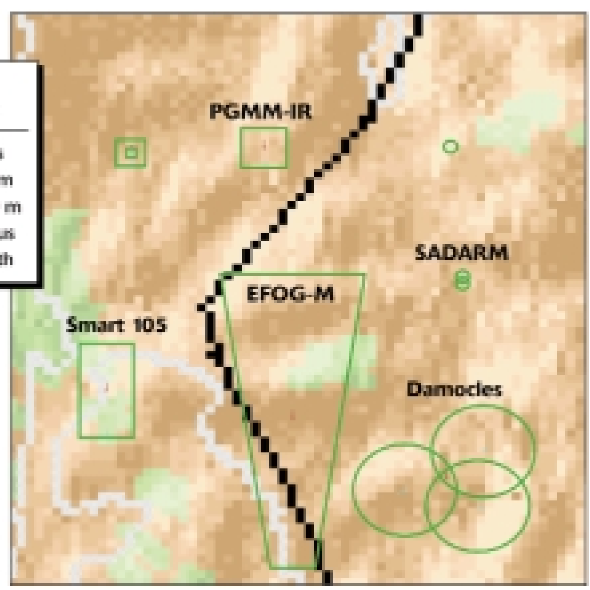


Figure 3.17—Some First-Order Characteristics of Different Indirect-Fire Systems

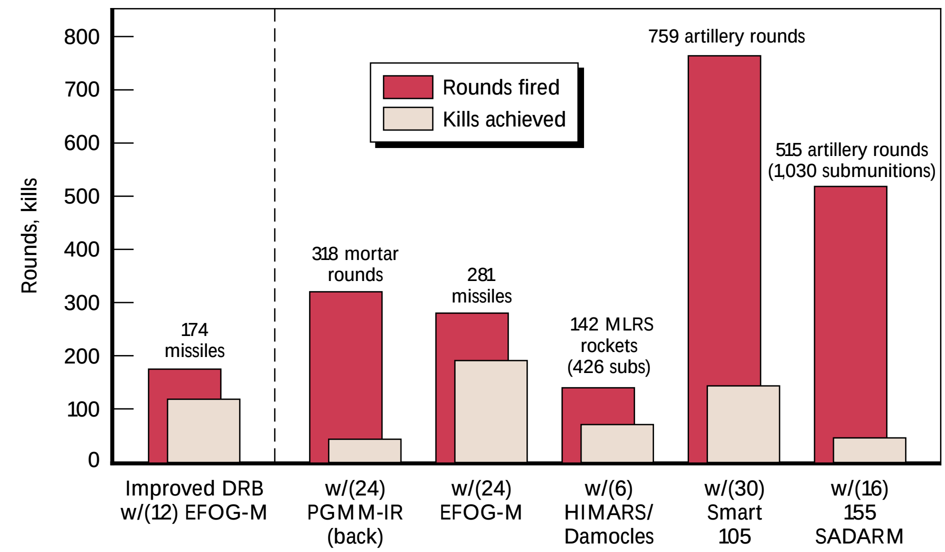
In addition to range, the indirect-fire systems also vary in the size of their munition search footprints. This characteristic generally defines the munition's ability to encounter a target and is a function of its sensor field-of-view and its maneuver capability. The figure shows the relative sizes of the search footprints of the different munitions.

What happens when we compare the alternatives? When we substitute different indirect-fire systems for EFOG-M (using the DRB system trade-out approach), we find that only one of the alternatives performs as well as EFOG-M, using LER as the key measure.[7] The low-performing systems and munitions were PGMM and 155 SADARM, which do only somewhat better than the baseline DRB force (LER = 4.1). PGMM did not do very well for several reasons: movement of the targets under the footprint during the flyout, competition with direct-fire systems such as TOW and Apache, and multiple attacks on the same target. 155 SADARM had greater range than PGMM, but with its small footprint, it was generally not very effective at engaging moving armor targets.

Interestingly enough, because of its large footprint, HIMARS-Damocles showed its added contribution to counterbattery fire even when used in the anti-armor mode. Using this system provided an outcome between a draw and a win. Both Smart 105 and EFOG-M resulted in wins. Replacing the 12 EFOG-M launchers in the enhanced DRB with 12 105mm howitzers resulted in a higher LER (11.5 versus 10). Much of this occurs because of the resulting large numbers of cannons (now a total of 30) that can all fire the effective Smart 105 round. However, in a more analogous comparison (the 8 155mm cannons are traded out for 12 more EFOG-M launchers), 24 EFOG-M launchers result in an even higher LER than the 30 105mm cannons with Smart 105 (13.7 versus 11.5).

Figure 3.18 compares the efficiency of the different systems and munitions by looking at rounds or missiles fired and targets killed. EFOG-M, with its man-in-the-loop control, was by far the most efficient. The other systems varied widely in efficiency. PGMM and 155 SADARM fired large numbers of rounds but killed few targets. HIMARS-Damocles achieved a high percentage of kills per rocket, but each rocket contained three submunitions. Smart 105 achieved a substantial number of kills, but it fired almost three times as many rounds as EFOG-M launchers fired missiles. (TTPs on rounds fired per target were designed to yield a high expected probability of kill, approximately 1.0.)

In addition to total rounds fired and kills, the table at the bottom of Figure 3.18 shows (beyond the LERs discussed above) the pounds of munition weight per kill, the total tons per kill of each indirect-fire alternative's slice (which includes the launcher, ordnance, and support vehicles), and the approximate number of C-141 equivalent sorties for that alternative's slice. Some of these factors require additional explanation. For example, the number of tons attributed to 24 PGMMs and 24 EFOG-Ms were each more than twice that of 12 EFOG-Ms, even though all these systems are HMMWV-mounted. This is because each 24-system, two-company section adds a headquarters unit not present in the 12-system force. Smart 105 and 155 SADARM have an even



	Improved DRB w/(12) EFOG-M	w/(24) PGMM-IR (back)	w/(24) EFOG-M	w/(6) HIMARS/ Damocles	w/(30) Smart 105	w/(16) 155 SADARM
Munition lbs/kill:	185	300	170	104	260	1,180
Total tons/kill:	1.7	10.2	2.2	5.5	12.8	19.6
C-141 sorties:*	9	21	22	24	88	51

*Per unit, e.g., EFOG company; assumes Desert Storm planning factors (20 tons per C-141); 360 sorties for 7,200-ton DRB.

Figure 3.18—Comparison of Efficiency of Different Indirect-Fire Systems

higher weight burden, since we have to include the standard ordnance (smoke, illumination, HE rounds, etc.), along with their trucks and handling systems. When these systems were traded in against HMMWV-mounted EFOG-Ms and PGMMs, only the launchers and smart munitions components and support were considered.

The reach of each weapon system was determined by a combination of its range and its position on the battlefield (the TTPs assumed), while the weapon's effectiveness, by distance, was determined by simulation. HIMARS/Damocles and PGMM-IR exhibited very different distributions of kills by range. Figure 3.19 shows kills by the advanced system, which are shown separately from the kills by all other systems combined. All results are cumulative over time up to the same stopping point, approximately one hour after the start of the battle. EFOG-M (24) was able to fire at longer ranges (with some of the systems placed forward) and at danger close, resulting in kills spread over the battlefield. HIMARS was primarily a mid- to long-range system, unable to fire close to its own troops because of its large-munition footprint and MLRS rocket ballistic error. PGMM-IR was a close-in system and often competed for targets with other systems in the force.

Unlike EFOG-M, the cannon-fired artillery rounds have extremely fast flight speed (thus reducing errors associated with target movement). Even so, the 155 SADARM had a low level of mid-range kills, primarily because of the seeker's small footprint,

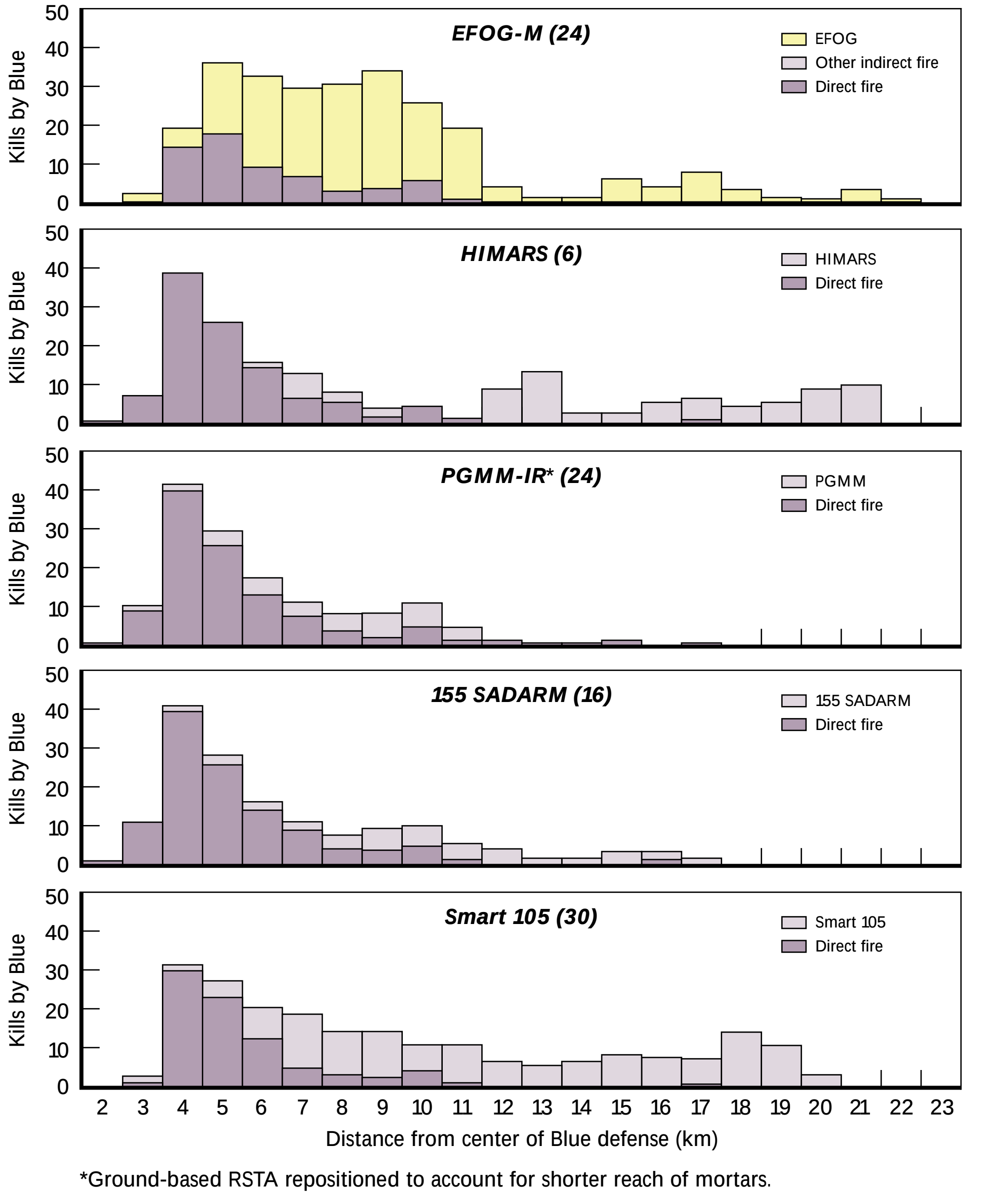


Figure 3.19—Comparing the Reach of the Different Indirect-Fire Systems

which limited its ability to encounter the mobile targets. This contrasted sharply with the broad range of kills by the conceptual Smart 105 system, which had a much larger footprint combined with a fast response.

Besides comparing the systems side by side, we also compared the added benefit of different systems in conjunction with some EFOG-Ms (where the EFOG-Ms are positioned forward).[8] Because we are including two types of advanced indirect-fire systems, fewer numbers are available than before. Generally, we found the alternative systems and munitions replacements tended to complement EFOG-M in different ways. PGMM-IR and 155 SADARM both contribute a small but significant number of kills, without stealing from the EFOG-M kills. PGMM kills are closer in than 155 SADARM and tend to fill in some of the interval when EFOG-M launchers are moving.[9] 155 SADARM kills are farther out and actually increase EFOG-M kills slightly, apparently by destroying Red systems that threaten EFOG-M launchers and hunters during the pullback.

HIMARS-Damocles had two effects: It engaged targets at very long range and it provided a means for highly lethal counterbattery fire, reducing losses from Red artillery. This results in a higher LER than would be expected from the number of kills by Blue. Smart 105 is a very lethal system, with its moderate range and high probability of acquisition and kill. The 18 105mm howitzers are able to achieve more kills than the 12 EFOG-M launchers.

Figure 3.20 summarizes the results of the analysis of indirect-fire alternatives, in terms of both data comparison and performance assessment. The data we used to characterize each indirect-fire system generally originated from its developer. Although we questioned the validity of certain items, we ultimately used the data provided. In some cases, it was apparent that systems in conceptual or early development stages incorporated more optimistic projections than those proven in testing. Nonetheless, using the data as provided (shown on the left side of the figure), in conjunction with TTPs recently discussed with the user/developer, allowed us to assess the performance of the different indirect-fire concepts in the context of the stressing LANTCOM scenario.

The combination of data, TTPs, and interactions with other systems on the battlefield (including C2 network/delays) provided the opportunity to quantify performance at a higher level (as summarized on the right side of the figure). For example, the ability to encounter targets was partly determined by the data (sensor capability, time of flight, etc.) but was also influenced by the C2 interactions. Another example, the ability to reach, was determined partly by the range of the weapon but also by the placement (using inherent mobility) on the battlefield. EFOG-M was the only weapon that could generate targets on its own, identify targets after launch (increasingly important in lower-intensity conflicts), and provide a means for battle damage assessment (BDA). Finally, both EFOG-M and Smart 105 appeared to be high-leverage weapons for the DRB, especially against mobile targets. On the other hand, both PGMM and 155 SADARM did not fare as well.

In summary, among the indirect-fire options, EFOG-M provided the highest LER, while Smart 105 and HIMARS with Damocles offered the next-highest LERs. Smart 105, because of its large numbers, good reach, large footprint, fast response, and high lethality, was an attractive system. HIMARS was relatively efficient in terms of kills per rocket with the large-footprint Damocles munition, but it was restricted to company-sized targets and, with its substantial system weight, had only a few launchers to work with. Finally, the smaller-footprint smart munitions (PGMM and SADARM) did

Weapon system/munition concept	Data comparison					Performance assessment			
	Max range	Delivery accuracy	Time of flight	Munition footprint	Warhead lethality	Ability to encounter	Ability to reach	Generate/ ID/BDA	Value to DRB*
PGMM-IR	Moderate	Poor	Moderate	Moderate	Good	Poor	Poor	Poor	Poor
EFOG-M	Moderate	Good	Poor	Good	Good	Good	Moderate	Good	Good
HIMARS/ Damocles	Good	Poor	Moderate	Good	Good	Good	Good	Poor	Moderate
155 SADARM	Moderate	Moderate	Good	Poor	Moderate	Poor	Moderate	Poor	Poor
Smart 105	Moderate	Moderate	Good	Moderate	Good	Moderate	Good	Poor	Good

Good Moderate Poor

*Based on modified LANTCOM scenario, anti-armor mission, with DRB in defensive position (as defined earlier).

Figure 3.20—Summary of Data Comparison and Performance Assessment for Indirect-Fire Alternatives

not fare well against moving armor because the targets would often move out of the encounter zone of the munition.

Chapter Summary

In this chapter we examined enhancements for current rapidly deployable forces, such as the 82nd Airborne Division DRB. We found that without changing numbers of systems, required lift, organization, or mission, new systems and tactics could strongly improve overall force effectiveness. Replacing direct- and indirect-fire systems, adding air and ground sensors, and streamlining the C2 system allowed the force to operate successfully, even though it was outnumbered by attacking enemy armor. Of the various weapons in these near-term forces, EFOG-M was found to have the greatest efficiency of operation. As the conditions became more stressful, with close terrain and a more advanced threat, a richer mix of sensors and weapon systems was required.

The primary operational difference observed by using a new concept and enabling technologies was the extension of the DRB's battlespace. The approaching enemy heavy force was engaged at much greater range by precision systems that could kill armor. Across-the-board improvements were noted in enemy systems killed and enhanced survivability for the U.S. force. This is not to say the battles would have been easy, for in several cases it is likely that the enemy could still have closed in on the DRB in a final attempt to overrun its defenses. Additionally, it should be noted that the different terrain types in the three cases again had considerable effect on the outcome. The relatively open terrain of SWA facilitated target detections and long-range engagements, while the closer terrain of Eastern Europe hindered the process, leading to more direct-fire fighting.

The direct-fire battle, the "end game" of the defense if you will, was still important, even critical. In this set of cases, the direct-fire battle was made less stressing because the enemy had suffered so many casualties from standoff systems before it closed into direct-fire range.

This chapter was fundamentally based on current structure fighting with conventional tactics. The next chapter will examine the potential of not only enhancing the sensor and weapon systems of the DRB, but also fighting in a much more dispersed manner, where tactical concepts will vary as well as the weapons.

CHAPTER THREE ENDNOTES

1 The RFPI was a joint effort between the Office of the Secretary of Defense (OSD) and the U.S. Army; RAND support to the RFPI ACTD was jointly sponsored by USD(A&T) and ASA(RDA).

2 Different concepts have been researched and early versions demonstrated by defense contractors. These include TRW and its solid-state laser system and Westinghouse and its chemical mid-wave IR laser technology.

3 Recall that a loss is represented by an LER below 6:1; a draw, by LERs greater than 6:1 and less than 10:1; and a win, by LERs greater than 10:1.

4 In simulating the future Red force, we presumed the attack would be carried out like it was for the existing Red force (where Red attempts to overwhelm the smaller DRB from multiple axes of attack). In the future, the threat may adopt new ways to fight that mirror recent U.S. thinking (e.g., dispersed forces, maneuver by fire, use of deception), which were not assessed in this work.

5 It is postulated that a certain level of mobility, similar to artillery operating in shoot-and-scoot mode, may reduce the effects of top-attack weapons. However, this was not examined in this work.

6 ADAS is a five-microphone sensor system being built by Textron, Electronic Systems Division. Other unmanned ground sensors are being considered for ground forces, and ADAS provides a good exemplary use of such systems.

7 Other measures include cost-effectiveness and lethality per round fired and lethality per pound of deployment weight (for the respective units), which were also examined in the analysis (see Figure 3.18).

8 Forward placement of EFOG-M was used in this instance because of excursion sequencing; later runs showed rear placement to be superior.

9 PGMM-IR is one of several smart mortar cases examined; the most effective of these cases is when it is placed back in the force.