
SUMMARY

Since the end of the Cold War, U.S. forces have been involved in a number of operations (peacekeeping, humanitarian relief, and non-combatant evacuations) that have taken place in urban settings. Peace operations in Somalia, especially the deaths of 18 U.S. servicemen and the wounding of almost 100 others on October 3, 1993, profoundly influenced the American public's perceptions of modern urban combat in the developing world. For military professionals, Somalia also was a painful reminder that the technological and operational dominance the United States experienced on the conventional battlefield during Desert Storm did not necessarily carry over into urban peacekeeping. For infantrymen in particular, the fierce fighting of "Bloody Sunday"—the most intense light infantry engagements since the Vietnam War—brought home the relevance of urban combat, its nastiness, and the need to develop concepts and tactics better suited to this unique environment.

This report assesses the likelihood that the U.S. military will be called upon to conduct urban operations; explores the political, legal, and physical aspects of the urban operational environment; presents new concepts to accomplish key operational tasks; identifies key technologies that will need to be developed to execute these concepts; and offers lessons from past operations.

KEY FINDINGS

Key findings of this study are as follows:

- Global urbanization, particularly in the developing world, makes it highly likely that many—if not most—future military operations will have an urban component (although not necessarily one involving fighting).
- However, an increase in urban operations does not mean that conflict has become primarily an urban phenomenon or that non-urban military operations have been eclipsed. Rather, built-up areas are yet another environment in which military forces must be prepared to operate.
- Urban areas, with their physical and social complexity, are extremely difficult to operate in. Where possible, U.S. forces should avoid them. Aerospace forces can help preclude some urban military operations through deterrence, early warning, and rapid humanitarian or military intervention. Along with ground-based long-range fires, aerospace forces can also interdict adversary forces, potentially preventing them from reaching urban areas.
- Where urban operations cannot be avoided, aerospace forces can make important contributions to the joint team (air, land, sea, and space forces working together): detecting adversary forces in the open; attacking them in a variety of settings; and providing close support, navigation and communications infrastructure, and resupply for friendly ground forces.
- Offboard sensors for manned aircraft, three-dimensional urban mapping, Global Positioning System (GPS) relays on unmanned aerial vehicles (UAVs), and limited-effects weapons¹ have the potential to enhance the ability of aerospace forces to detect and attack adversary forces when rules of engagement are highly restrictive, such as in peace operations, noncombatant evac-

¹*Limited-effects weapons, or munitions*, are designed to incapacitate or kill personnel targets without harming nearby civilians or friendly forces. Small, slow-moving weapons with grenade-like explosives or nonlethal warheads will be necessary to achieve this goal.

uations, and humanitarian assistance. Their development should be encouraged.

- Three-dimensional mapping and GPS relays also have the potential to substantially improve the situational awareness of friendly ground forces, allowing the smallest units as well as their commanders to know their location (both GPS coordinates and position in buildings). Coupling these technologies with laser rangefinders should allow friendly forces to quickly map the location of engaged adversary forces.
- Automated integration and pattern analysis of inputs from large, multiphenomenology sensor networks (i.e., sensors that use acoustic, infrared, seismic, chemical, and radar detectors) will be necessary to interpret the massive volume of activity found in most urban areas.
- But, in the type of limited operations this report emphasizes, we think it *unlikely* that automated classification of weapons, adversary personnel, or vehicles will be sufficiently reliable to permit lethal fires to be put automatically on targets. Rather, we expect that practical limitations of automated fusion, coupled with political concerns about collateral damage and civilian casualties, will dictate at least one human decisionmaker remaining in the loop between sensor and shooter.
- As long as human decisionmakers remain in the loop between sensor and shooter, human-machine interfaces will be a critical information-architecture issue. A major challenge will be developing the organizational processes that make quick decisions possible in light of the likely uncertainty and ambiguity associated with real combat. Without a responsive and agile command and control system, an elusive and adaptable adversary is likely to be there and gone before weapons can be brought to bear.

THE NEED FOR IMPROVED URBAN OPERATIONAL CAPABILITIES

Are urban-centered conflicts becoming more common? Are they a new form of warfare that will supplant traditional maneuver warfare in the open? These intriguing questions deserve serious and careful

consideration by defense planners and researchers alike. At this point, there is insufficient evidence or analysis to answer these questions. Defense planners—who must walk a narrow path between apocalyptic and complacent visions of the future security environment—should focus, at least for now, on ensuring that the U.S. military can meet a broad range of urban-operation challenges, whether in major wars or small-scale operations.

The best argument for improved capabilities for urban operations is that, despite its best efforts to avoid cities, the U.S. military has had to fight in them in diverse circumstances. As well, in an increasingly urbanized world, noncombatant evacuations, humanitarian relief, and other noncombat operations are likely to take place in urban settings. The military is tasked in many such operations, because armed interference is a possibility. Although U.S. forces have usually been able to avoid combat during these operations, they must be prepared to conduct urban evacuations and humanitarian relief in the face of armed opposition. In short, whether in conventional conflicts or in smaller-scale contingencies, there is a good chance that U.S. forces will be called upon to operate in urban settings. The probability or desirability of urban operations need not be overstated to acknowledge that prudent defense planning requires that the United States develop the doctrine, training, organizations, equipment, and concepts of operations to be effective in this unique and difficult environment.

Planners also need to distinguish clearly between the problem of conducting military operations in the midst of a civilian population and that of fighting in the rubble of a largely abandoned city. The former problem is more complex and deserves analytic attention. As the Department of Defense (DoD) places more emphasis on peace, relief, counterterrorism, and other operations at the lower end of the conflict spectrum, planners, operators, and analysts must all gain a deeper understanding of the human and physical intricacies of the urban environment.

NEW CONCEPTS

Owing to their political, legal, and military complexity, operations at the lower end of the spectrum will be the most common and challenging urban missions the USAF will face. Although the USAF can

improve its ability to conduct urban operations against conventional foes, the major shortcomings will be in situations where unconventional foes are conducting limited operations; therefore, we present new concepts directed at those situations.

It may be possible in future limited operations to identify and attack critical adversary centers of gravity or key nodes. However, historical experience suggests that this is the exception rather than the rule. In most limited conflicts, strategic objectives are more likely to be achieved through the cumulative effect of persistent surveillance and strike than through the destruction of a fairly small target set (e.g., an adversary's headquarters).

For example, in a notional peace operation that included an urban component, U.S. objectives might be to stop the violence, resettle the population, and achieve a return to normal in which routine civil and economic activities could take place without disruption. To accomplish these objectives would require, above all else, that friendly forces control the streets. The operational task of controlling the streets would, in turn, require that a variety of tactical tasks be accomplished. Table S.1 lists some of the more prominent tasks, along with the concepts of operation we propose for their accomplishment.

NEXT STEPS

The fielding of new urban surveillance, strike, and navigation technologies, when combined with innovative concepts of operation, could yield a significant improvement in USAF and joint capabilities for urban operations. In particular, the integration of ground sensor networks, low-flying air-launched UAVs, and more-traditional surveillance platforms with other platforms carrying limited-effects weapons could make joint forces much more effective in constrained urban operations. Developing the ability to detect, identify, and eliminate room-sized targets without collateral damage is a natural step in the ongoing evolution of aerospace power, simply continuing current trends in command, control, communication, intelligence, surveillance, and reconnaissance (C3ISR), battle management, and precision strike.

Table S.1
Operational Tasks and Concepts of Operation

Operational Task	Concept of Operation
Stop movement of combatants, vehicles, equipment	Air-dropped lifting-body sensor with parafoil extends eyes of manned platforms
Provide rapid high-resolution imagery for target ID	Offboard sensors flying at lower altitudes aid combat aircraft in identifying targets
Detect and neutralize adversary's ambush positions	Pattern analysis for anomaly detection RF resonance detector on UAV
Detect and neutralize snipers	Passive infrared sensor on UAV detects bullet in flight; glide bomb kills sniper
Monitor high-priority targets	UAVs-ground sensor-special operations force (SOF) team provide high-resolution imagery
Resupply isolated friendly ground forces	A GPS-guided canister of prepackaged basic supplies is released from a variety of altitudes to fly to isolated unit
Provide close support to friendly ground forces	Fighter-released UAVs use GPS/3-D maps/lasers to fly to and identify adversary's position UAV fires multiple grenade-sized explosives through window

For these capabilities to be realized, several areas will require more focused attention:

- Air-launched offboard sensors
- Limited-effects munitions and associated platforms
- Non-imaging sensors for ground networks (particularly weapon-detection and explosives-detection technologies)
- Three-dimensional mapping and databases
- Sensor fusion
- Joint command and control of aerospace and ground forces.

Budgetary realities and current modernization priorities mean that funds available for enhancing USAF urban capabilities are limited. For that reason, we recommend that the USAF continue modest re-

search in this area to identify the most-promising and versatile technologies. Additional research and testing will have to be done before there is sufficient data on performance and cost for the USAF leadership to make informed decisions on whether to field systems such as those discussed in this report.

For the near term, we recommend that one of the USAF major commands or a battle laboratory be given responsibility to do additional research and development of these systems. To make the most of limited R&D funds, USAF laboratories should seek to partner with the Defense Advanced Research Projects Agency (DARPA) and other interested parties—perhaps under the auspices of an Advanced Concept Technology Demonstration (ACTD) program—to build and test prototypes of the more-promising systems. U.S. allies are likely to be important players as well; they have developed a variety of nonlethal, countersniper, and other systems that apply in urban operations.

Ultimately, urban operations are a joint problem. Theater commanders, the joint staff, and DoD will have to determine which mix of capabilities offers the most robust force for urban operations. Specific sensor and weapon choices will have to be made on the basis of some combination of coverage rate, resolution, versatility, responsiveness, cost, proportional/adjustable effects, and ease of delivery. Urban-specific measures of effectiveness (MOEs) may be needed to evaluate options for accomplishing the various tasks. As promising technologies are identified, realistic field testing, simulation, modeling, and red-teaming² will be necessary to determine which, if any, of them are sufficiently robust under real operational conditions to justify fielding.

Some of the possibilities discussed in this report, such as urban pattern analysis³ and the fusion of aerospace-ground sensor inputs, belong in a joint fusion or command center. Therefore, these capabilities should be developed under joint initiatives. Indeed,

²A *red team* seeks to identify clever countermeasures that adversaries might develop to defeat U.S. systems or concepts.

³*Urban pattern analysis* involves collecting data on urban activities (e.g., movement of people or vehicles) in order to detect anomalies that might be associated with adversary activity.

some of the most difficult issues are related to joint command and control of urban operations. For example, coordinating joint fires to prevent friendly forces from firing on one another will become a bigger problem if the number of standoff weapons used in urban operations are increased. If significant numbers of friendly forces are on the ground, will all urban air strikes be considered close air support (CAS)? Or will aerospace forces operate more autonomously in some parts of the city? These are just a few of the many issues that need to be resolved before highly integrated urban aerospace-ground operations become feasible.

It would be unfortunate, however, if excessive concern about budgetary constraints, combined with somewhat outdated views of the limitations of aerospace power, prevented promising new capabilities from being fielded. Ironically, airmen are often as likely as infantrymen to narrowly define the settings in which aerospace forces can contribute. A more expansive vision of aerospace power would see the urban canyons of the world as part of the continuum of the vertical dimension that runs from the ground to orbital altitudes and would embrace nontraditional systems—such as air-dropped UAVs—as simply another tool in the airman’s kit bag. The USAF excelled during the twentieth century at going higher, faster, farther. To meet the challenges of the early twenty-first century, the USAF may also need to exploit unmanned and robotic systems so that it can go lower, slower, and closer against unconventional threats to U.S. interests.